CONSULTANT REPORT

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Public Interest Energy Research
CALIFORNIA ENERGY COMMISSION

Energy-Related
Environment Research

REDUCING WILDLIFE INTERACTIONS WITH ELECTRICAL DISTRIBUTION FACILITIES

Gray Davis, *Governor*

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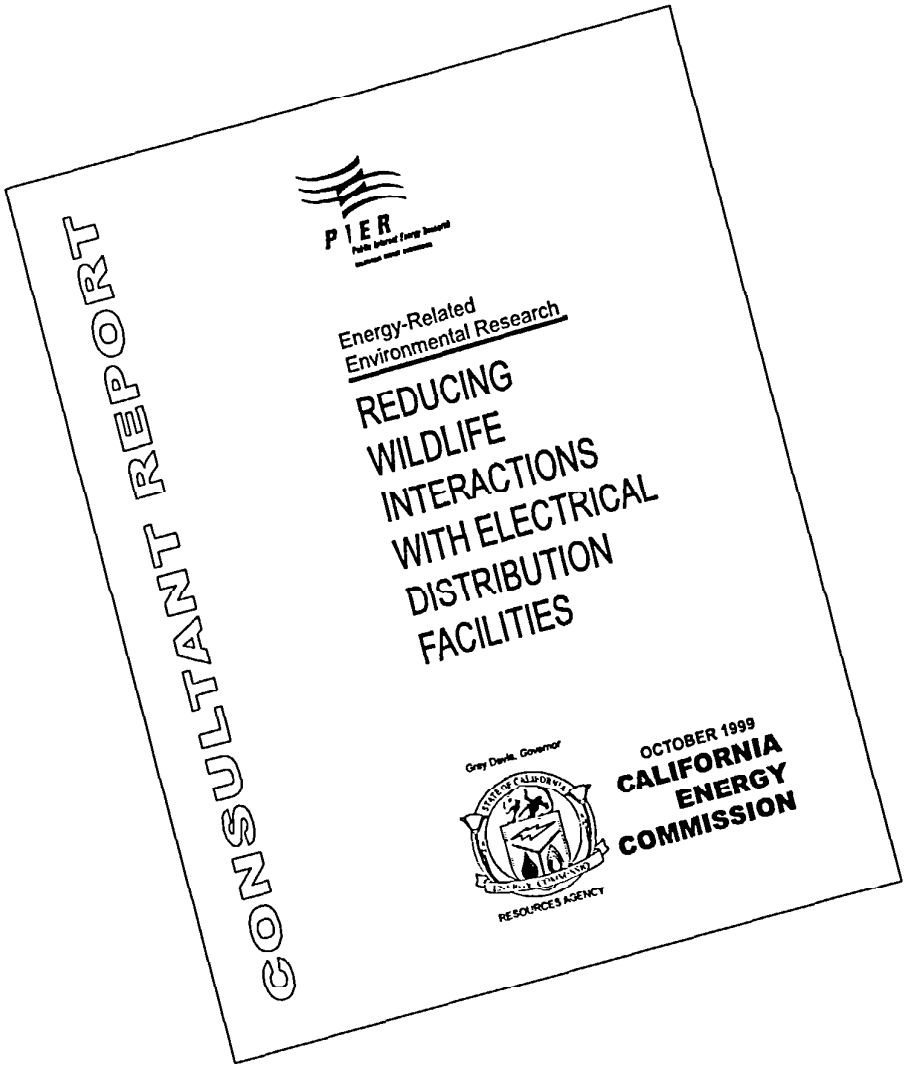

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The following ideas and discussion of wildlife protective products and designs are not binding in any way on Colson & Associates, Edward W. Colson, Principal, or Pacific Gas & Electric (PG&E). The art of reducing bird electrocutions and collisions on powerlines is evolving and ideas change as we learn more about bird and animal behavior and cost-effective engineering alternatives. Although, specific products and suppliers in this report are mentioned, they are offered as examples of the kinds of products that have worked and, in some cases, have not worked in previous applications within the industry. Please note, no endorsement or recommendation of any specific product or supplier has been made.

There are currently many vendors, including some not mentioned who have similar products. Many of these companies distribute state-of-the art products or will custom build bird deterrent devices according to client specifications. Instructions for the proper and safe installation of these products are the responsibility of the manufacturer and installer. Many of these products, including wildlife covers, protective boots, bushing covers, electrostatic animal guards, insulated wire, bird flight diverters, perch guards, and other insulated devices, are not designed to protect humans from electrical harm. They are primarily designed for brush contact from animals and birds. All personnel assigned to work with these products should be instructed and warned of the safety hazards as identified by the manufacturers.

Acknowledgments

This study was funded by the California Energy Commission (Commission) and managed by Pacific Gas and Electric (PG&E). The study consists of two sub-studies: a wildlife and powerline assessment tool and wildlife devices. The development of the wildlife and powerline assessment tool was a true collaboration between many players. Consultation with Kevin Cornish, Electric Distribution, PG&E was important to the success of this project through his clear understanding of the needs of PG&E's electric distribution planners and engineers. We are also grateful to PG&E's electric distribution engineers and others who provided valuable user feedback that helped steer the project to meet their needs. Biologists Ron Critchlow, Ellen Yeoman and Ed Colson, provided early guidance with the concepts behind using a geographic information system to evaluate the risk of wildlife interactions with electric distribution facilities. Special thanks to: David Thomas (Building and Land Services, PG&E), Jody Cummings (Building and Land Services, PG&E), Robert L. Mulder (Technical & Ecological Services, PG&E) and Jim Sanborn (Engineering and Planning, PG&E) for their work in developing the Geographic Information System.

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Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Commission), annually awards up to $62 million through the Year 2001 to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following six RD&D program areas:

- Residential and non-residential buildings end-use energy efficiency
- Industrial, agricultural, and water end-use energy efficiency
- Renewable energy technologies
- Environmentally preferred advanced generation
- Energy-related environmental research
- Strategic energy research.

In 1998, the Commission awarded approximately $17 million to 39 separate transition RD&D projects covering the five PIER subject areas. These projects were selected to preserve the benefits of the most promising ongoing public interest RD&D efforts conducted by investor-owned utilities prior to the onset of electricity restructuring.

What follows is the final report for the Reducing Wildlife Interactions with Electrical Distribution Facilities project, one of nine projects conducted by Pacific Gas and Electric Company. This project contributes to the Energy-Related Environmental Research program.

For more information on the PIER Program, please visit the Commission's Web site at: http://www.energy.ca.gov/research/index.html or contact the Commission's Publications Unit at 916-654-5200.

Executive Summary

This project had as its overall objective the reduction of wildlife interaction with electrical distribution facilities in Pacific Gas and Electric (PG&E)'s service territory. The project was divided into two phases: the development of a wildlife and powerline assessment tool and an evaluation of wildlife devices. Together they constituted significant progress toward the overall objective of reducing wildlife interactions with electrical distribution facilities in Pacific Gas and Electric (PG&E)'s service distribution territory.

Wildlife and Powerline Assessment Tool

This part of the project continued an earlier Research and Development (R&D) project to develop an information tool for electric distribution planners. Use of this information would give planners a better understanding of how existing circuits could be improved, and how new circuits should be designed, to reduce the chances of animal-caused outages and animal electrocutions.

The information tool was developed in response to a 1994 settlement agreement between PG&E and the U.S. Fish and Wildlife Service that arose after citations were issued for the electrocution of several Swainson's hawks on transformer poles in the Southern San Joaquin Valley. Among several stipulations, the settlement agreement specified that PG&E should develop a risk model for its service area to indicate high-risk areas where birds are more vulnerable to electrocution.

In the earlier project, PG&E developed a prototype information tool, based on a geographic information system (GIS) called ArcView© (ESRI 1997), for a pilot study area (PG&E's Stockton Division). A GIS is a software application that provides a means to store, present, and analyze a combination of mapped features (spatial data) and the data associated with those features.

The prototype assessment tool included multiple themes of spatial information:

- A geographic land base composed of major and minor roads; water features, such as. rivers or lakes; city boundaries, parks and related administrative boundaries; and a shaded topographic relief background.
- PG&E facility spatial data, including a representation of electric distribution lines and equipment poles, such as transformers, capacitors, switches, fuses, and reclosers.
- Bird- and squirrel-caused outage information, including the ability to predict the occurrence of various wildlife species

The results of this earlier study were encouraging. Electric planners and estimators indicated that the assessment tool showed promise and would probably be used when planning new circuits and retrofitting old ones (PG&E 1999). They were particularly interested in the flexibility that this tool offered in displaying and analyzing outage information over a geographic land base. The major issues that remained at the close of the pilot study were how to provide multiple copies of the system throughout PG&E and keep all of the datasets current for those copies.

Objectives

- Implement the wildlife and powerline assessment tool developed in the pilot study throughout PG&E's service territory.
- Encourage use of the assessment tool by planners to better design new circuits in areas vulnerable to wildlife-caused outages.
- Ensure compliance with the settlement agreement between PG&E and the U.S. Fish and Wildlife Service.

Outcomes

- The wildlife and powerline assessment tool is now available for use throughout PG&E's service territory.
- Planners are gradually discovering its usefulness in designing new circuits.
  - Training is in high demand and user feedback is extremely positive.
- The assessment tool provided the required risk model to comply with the settlement agreement between PG&E and the U.S. Fish and Wildlife Service.

Conclusions

- The use of the wildlife and powerline assessment tool is increasing and allows planners, engineers, and others to:
  - Determine where bird-caused outages have historically occurred.
  - Predict the location of sensitive species and habitats.
- Because the assessment tool relies on an off-the-shelf application, it is readily available for use by other utilities.

Recommendations

<u>Training</u>

- PG&E's electric distribution planners and engineers should be trained in and exposed to the wildlife and powerline assessment tool.

<u>Data Maintenance</u>

- PG&E needs to allocate funds to support the data used by the wildlife and powerline assessment tool.

<u>Technical Transfer to Other Utilities</u>

- Public funds should be allocated to share the knowledge gained in this project with other utilities. Once utilities become familiar with the wildlife and powerline assessment tool, they can determine if it could be implemented in their service area.

Wildlife-Protective Devices

This part of the project addressed improvements in the installation of wildlife-protective devices on electrical distribution equipment and seeks further understanding of how such devices degrade in the field. Over the last few years, PG&E identified some add-on wildlife protective products that degraded in the field.

PG&E is divided into 18 separate divisions within seven areas to meet customer needs and maintenance requirements. PG&E modified hundreds of poles to increase phase separation and installed thousands of wildlife protective devices on distribution poles and related facilities in its service area.

Despite these efforts, wildlife-caused outages in the PG&E service area have risen at a rate of eight to nine percent annually over the last decade. Part of this rise may be attributable to the proliferation of local species, such as starlings or squirrels, which increase the risk of electrical outages on powerlines. Another contributing factor may be PG&E's greater emphasis on the investigation of all reported outages that reduces the number of unknown incidents.

In either case, there is a critical need for the investigation of devices and products installed in the field to ensure that remedial steps now being taken are appropriate and to identify products or installation procedures that may contribute to increased wildlife-related outages. The results are based on a preliminary sample of 253 poles in the PG&E service area.

Objectives

The initial objective of this study was to better understand the expected life span of the wildlife protective devices, installation techniques, and to recommend improvement areas, as appropriate. However, as the work progressed it became apparent that the devices were not always installed correctly. Therefore, and additional objective was added to examine the installation procedures for these devices.

- Improve installation procedures for Wildlife protective devices.
- Understand the expected life span of the wildlife protective devices, installation techniques, and to recommend improvement areas, as appropriate.

Outcomes:

- Approximately 15 percent show a degree of degradation that is likely to reduce their performance.
- Approximately 65 percent of the poles observed had wildlife protective devices that were not installed according to manufacturer recommendations or PG&E Engineering Standards. Installations were incomplete or improperly executed

Conclusions

- Age and chemical composition are the leading factors affecting the degradation rates of the observed wildlife protective devices.
- Poles were found with wildlife protective devices not installed according to manufacturer recommendations or PG&E Engineering Standards.

Recommendations

Training

- Additional training sessions should be developed and improved to provide field crews with information on the safety, importance, use, and proper installation of add-on devices to reduce wildlife-created outages.
- A video should be developed demonstrating the relevance, proper use, and installation of all wildlife protective devices.

Installation Practices

- In areas with historical wildlife-caused outages and where birds concentrate, properly fitted wildlife protective covers and jumper insulation or insulated wire should be placed on all new equipment poles, particularly transformers, capacitors, reclosers, risers and sectionalizers before they leave the service yard.
- PG&E's installation standards should be followed more carefully.

Device Selection

- Wildlife bushing covers should be selected to fit the specific configuration of the equipment.
- Insulation wire covering should be purchased in rolls (not precut sections) to save cost and provide for cut to fit installation. Every effort should be made to cover jumpers completely, particularly those that pass directly over metal brackets or other horizontal surfaces where bushings are located.
- Electrostatic guards, such as the Guthrie Guard should be considered for use on all problem poles with bushing-mounted cutouts instead of the Lineway Protective cover.
- PVC-Based Eritech bushing covers should no longer be used within the PG&E service territory.

Maintenance Practices

- Material Problem Reports should be prepared for all cases of wildlife protective devices that fail in the field.
- All electric-line maintenance trucks should be stocked with a variety of wildlife protective devices to enable line personnel to install the devices on an as-needed basis. Although the trucks are often loaded with far more essential electrical hardware, at least a few such devices should be available for emergency or urgent installations.
- Poles modified with wildlife protective devices should be reinspected as a quality control measure after completion of the work.

Manufacturing Improvements

- Device manufacturers should continue to improve this product line. Further advances in material composition, design, and long-term aging are essential to the utilities' efforts to reduce wildlife-caused outages.

Abstract

This project supports the Public Interest Energy Research (PIER) program objective of improving the environmental and public health risk of California's electricity by improving current systems and technologies to prevent wildlife electrocutions caused by powerlines. The project aims to improve the reliability and quality of California's electricity by reducing wildlife-related power outages.

Pacific Gas & Electric (PG&E) evaluated the usefulness of a wildlife and powerline assessment tool that incorporates the electrical distribution network and several wildlife resource databases to reduce the risk for wildlife electrocutions and outages on selected circuits. PG&E developed a prototype assessment tool in 1997 to aid in predicting areas susceptible to wildlife interactions. Electric planners and engineers believe this tool could improve system reliability when used for planning new circuits or upgrading existing circuits. This project implemented the wildlife and powerline assessment toolthroughout PG&E's service area using a "map server" on the company's intranet. The project also analyzed devices that reduce or prevent bird- or animal-caused outages. PG&E evaluated the durability of specialized add-on insulation products and perch-deterrent products installed in the field. Preliminary laboratory teats conducted by PG&E during 1996-97 showed that some insulation products are susceptible to degradation caused by various environmental factors such as moisture, sunlight, and contaminants. Some materials deteriorated quickly in laboratory tests. PG&E recovered products that deteriorated in the field. This project examined the condition of various devices installed in the field as well as installation procedures.

1.0 Introduction

This project had as its overall objective the reduction of wildlife interaction with electrical distribution facilities in Pacific Gas and Electric (PG&E)'s service territory. The project was divided into two parts:

- Wildlife and Powerline Assessment Tool.
- Wildlife Devices.

Together they constituted significant progress toward the overall objective of reducing wildlife interactions with electrical distribution facilities in Pacific Gas and Electric (PG&E)'s service distribution territory.

Wildlife and Powerline Assessment Tool

This part of the project implemented and encouraged the use of a Wildlife and Powerline Assessment Tool throughout PG&E's service area. Prior to the development of this tool, planners had no practical, systematic and visual way of knowing where the high risk areas for bird electrocution and resultant system outages were. Further training in the use of the Wildlife and Powerline Assessment Tool would guide planners to the locations where the need for effective wildlife-protective devices is most critical.

Wildlife Devices

This part of the project was concerned with improving the installation of wildlife-protective devices on electrical distribution equipment and gaining a better understanding of how such devices degrade in the field. Ongoing training, improved installation practices, judicious selection of devices, diligent maintenance practices, and attention to manufacturing improvements all contribute to the reduction in wildlife electrocutions and to the greater reliability of the system.

1.1 PG&E Service Area and Divisions

PG&E is divided into 18 separate divisions within 7 areas to meet customer needs and maintenance requirements (Figure 1).

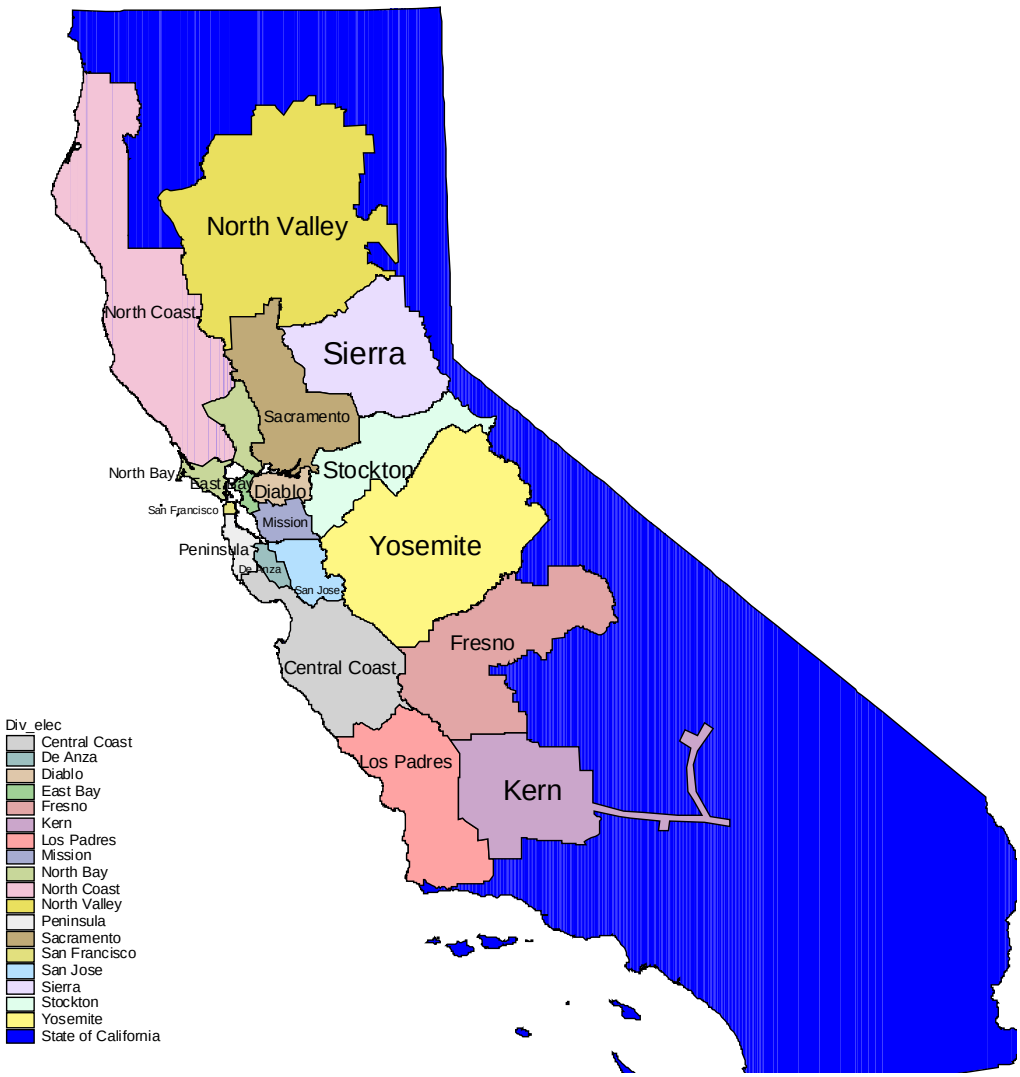

Figure 1. Map of PG&E Service Area with Division Boundaries

1.2 Report Organization

Section 2.0 of this report discusses the implementation of a wildlife and powerline assessment tool throughout PG&E's service area. Section 3.0 provides the result of investigations into the installation and condition of wildlife protective devices. Section 4.0 lists the references cited in the text.

There are five appendices:

Appendix I Typical Computer Session Using the Electric Distribution Map Server

Appendix II PG&E – Evaluating Wildlife Protective Devices 1998-1999 (Field Form)

Appendix III Ratio of 14 Different Wildlife Protective Devices to Overhead Line Miles Found in Each Division

Appendix IV Selected Photos of Degraded Wildlife Protective Devices

Appendix V Selected Photos of Improperly Installed Wildlife Protective Devices

2.0 Wildlife and Powerline Assessment Tool

Through support from the California Energy Commission's Public Interest Energy Research (PIER) Program, PG&E developed a wildlife and powerline assessment tool to address the needs of its electric distribution planners and engineers. The assessment tool is based on a geographic information system (GIS) implemented over PG&E's internal network (Intranet) through a client/server design- a map server- that enables a web browser to access a large variety of spatial data. A GIS is a software application that provides a means to store, present, and analyze a combination of mapped features (spatial data) and data associated with those features.

The spatial data available to the planners and engineers include facility information, such as electric distribution powerlines, equipment poles, and fuses. Other data include the locations of different types of unplanned outages. As a result of earlier research on wildlife interactions with electric distribution facilities, this map server project focused on providing planners and engineers with spatial information about wildlife.

The wildlife information includes

- Unplanned outages caused by birds, squirrels, and other animals.
- Prediction of wildlife habitat suitability.
- Locations of known occurrences of sensitive or legally protected wildlife species.

Using this information, planners and engineers can design circuits that minimize impacts on wildlife and reduce the potential for wildlife-caused outages.

Use of the wildlife and powerline assessment tool at PG&E is increasing. Planners and engineers report that it helped them improve their planning to reduce impacts to wildlife, minimize wildlife-created outages, and consequently, improve system reliability.

2.1 Background

This project continued an earlier Research and Development (R&D) project to develop an information tool for electric distribution planners. The initial objectives were to assist planners with the design of new circuits in areas that are vulnerable to reduced power reliability due to animal-caused outages. These outages typically occur when birds or squirrels bridge the gap between two phases on the primary side of the electric distribution system, typically between 12,000 and 60,000 volts at PG&E, or between a phase and a ground potential.

Company-wide, squirrels and birds are the fourth leading cause of electric distribution outages (CES 1997). Birds and squirrels are usually electrocuted when these outages occur. Because nearly all birds are protected by the Migratory Bird Treaty Act, their electrocution is also a compliance issue that this information tool was designed to address. The concept behind the tool was to show electric distribution equipment geographically in relation to where wildlife-caused outages have occurred and where wildlife species are known and predicted to appear.

PG&E hoped that by using this information, planners could have a better understanding of how existing circuits could be improved, and how new circuits should be designed, to reduce the chances of animal-caused outages and animal electrocutions. For example, if the information tool showed a cluster of bird-caused outages in an area that is also a likely habitat for golden eagles, the planner might consider using PG&E's raptor-protection construction standard in this area. This standard provides for adequate spacing between phases to reduce the risk of electrocuting birds as large as eagles.

The information tool was also developed in response to a 1994 settlement agreement between PG&E and the U. S. Fish and Wildlife Service that arose after citations were issued for the electrocution of several Swainson's hawks on transformer poles in the southern San Joaquin Valley. Among several stipulations, the settlement agreement specified that PG&E should develop a risk model that indicates high-risk areas where birds are more vulnerable to electrocution within their service area.

In the earlier R&D project (PG&E 1999), a prototype information tool was developed for a pilot study area. This prototype was based on a GIS called ArcView© (ESRI 1997). The pilot study area was PG&E's Stockton Division.

This prototype GIS included multiple themes of spatial information. These themes included a geographic land base composed of major and minor roads, water features, such as rivers or lakes, city boundaries, parks, and related administrative boundaries, and a shaded topographic relief background. PG&E facility spatial data also included a representation of electric distribution lines and equipment poles, such as transformers, capacitors, switches, fuses, and reclosers. Bird- and squirrel-caused outage information was also included. To address the need to predict areas at risk for outage caused by large hawks, themes were included that predict the occurrence of such species.

The results of this earlier study were encouraging. Electric planners and estimators indicated that GIS showed promise and would probably be used when planning new circuits and retrofitting old ones (PG&E 1999). They were particularly interested in the flexibility the GIS offered in displaying and analyzing outage information over a geographic land base. Major issues that remained at the close of the study were how to provide multiple copies of the system throughout PG&E and keep all of the datasets current for those copies.

In June 1998, the California Energy Commission's Public Interest Environmental Research (PIER) Program provided funding to continue the project described above. The remaining issues were successfully resolved by using PG&E's Intranet to distribute the wildlife and powerline assessment tool throughout the entire service area. Themes similar to those developed for the pilot study area were developed for the entire service area and new themes added to enhance the system's capability. Data updates are made on one server that then provides the information company-wide through the Intranet. The details of this system, how it is used at PG&E, how it meets PIER objectives and how other utilities could benefit from such a system are the subject of this section.

2.2 Objectives

This project's objects were to:

- Implement the wildlife and powerline assessment tool developed in the pilot study throughout PG&E's service territory.
- Encourage use of the assessment tool by planners to better design new circuits in areas vulnerable to wildlife-caused outages.
- Ensure compliance with the settlement agreement between PG&E and the U.S. Fish and Wildlife Service.

2.3 Methods

2.3.1 User Needs

The prototype wildlife and powerline assessment tool developed for the pilot study area provided valuable feedback from users in the Stockton Division and was the springboard for assessing user needs for this project. An initial review of these needs generated a list of appropriate data layers and system capabilities to include in the map server, which was presented to PG&E's Senior Electric Distribution Engineers for their review and comments.

2.3.2 Data Themes

PG&E included data themes that were determined to be useful in the design of new and upgraded circuits. Also included were PG&E facility data, as well as environmental information that addressed the issue of animal-caused outages and bird electrocutions. These themes were created from a wide variety of tabular and spatial databases available from within PG&E and from various California agencies and organizations.

2.3.3 Intranet Map Server

The application developed for this project used the Intranet map server software Autodesk MapGuide®, manufactured by Autodesk, Inc. The application is a client-server-based system. At PG&E, the client computers access the server using Microsoft's Internet Explorer® Web browser through PG&E's Intranet. The application is an "Active X®" control. Customization of maps and reports is implemented using a combination of server and client side "VBScript®" and "Javascript®" written in 'Microsoft Active Server Pages®'.

Themes are maintained and updated only on the server. This application solved two of the more important issues identified in the pilot GIS study:

- How to distribute the information to numerous users across PG&E's service area
- How to maintain the datasets used by these computers.

Although not quite as flexible as the ArcView© GIS used in the pilot study, the map server is powerful enough to display spatial data features and related attribute information. It is also easy to learn because it conforms to the format of the Web browser

that is familiar to many users. The PG&E GIS Services unit within the Building and Land Services Department had already developed similar map server applications for other business units. This project supported the development of a map server focused on the needs of PG&E's electric distribution planners and engineers.

2.3.4 Map Server Use and Support

In December 1998, PG&E released the map server for distribution engineers with most of its functions operational. They also demonstrated it to the Senior Electric Distribution Engineers at their quarterly meeting in January 1999. In April, PG&E solicited feedback from this group and from others expected to benefit from the system. At project inception, PG&E had hoped that an engineer or planner would be willing to use the system to aid in the design of several primary electric distribution circuits. However, this expectation proved to be too high. PG&E also queried its distribution department as to whether the map server would be supported at PG&E in the future; support would include data updates and feature enhancements.

2.4 Outcomes

- The GIS system is available for use throughout PG&E's service territory.
- While initially PG&E expected to implement the wildlife and powerline assessment tool using ArcView© on individual PCs, the project benefited from the use of PG&E's Intranet Map Server with centralized data. Planners are gradually discovering its usefulness in designing new circuits. Currently, map server training that includes the wildlife and powerline assessment tool is in high demand and user feedback is extremely positive.
- The wildlife and powerline assessment tool provided the required risk model to comply with the settlement agreement between PG&E and the U.S. Fish and Wildlife Service.

2.4.1 PIER Program Outcomes

The project met 3 of the PIER program objectives #2 (Increase the reliability of the electric system), #3 (Reduce the environmental impacts of electricity generation, distribution, and use), and #6 (Advance science and technology not provided by competitive and regulated markets). The reliability of the electric system is expected to improve where protection measures are implemented to reduce wildlife-caused outages. Objective #4 (Enhance California's economy) was met indirectly. The wildlife and powerline assessment tool should help guide planners to locate the areas within PG&E's large service area where such measures would be best implemented. By reducing the number of wildlife caused outages, objective #3 is also achieved by reducing the incidence of wildlife electrocutions. The wildlife and powerline assessment tool implementation at PG&E has also met objective #6 by advancing the science and technology of using GIS over the intranet with a unique combination of wildlife-related themes combined with utility facility information.

2.4.2 PIER Program Objectives

The PIER Program objectives were to:

- Reduce the cost of electricity and increase the value.
- Increase the reliability of the electric system.
- Reduce the environmental impacts of electricity generation, distribution, and use.
- Enhance California's economy.
- Demonstrate a connection to the market.
- Advance science and technology not provided by competitive and regulated markets.

2.4.3 Data Themes

The map server includes 44 themes that pertain primarily to the needs of electric distribution engineers (Table 3). The project, funded by PIER, focused on the development of these themes. An additional 24 themes can be presented from the default page. Other themes that present other facility information are also accessible to distribution engineers, but are targeted for other users at PG&E. Other sources within PG&E funded the development of these themes.

Table 1. Wildlife and Powerline Assessment Tool Data Layers;
their source, descriptions (where applicable), and visible map scale. Themes (data layers) in boldface were developed or processed specifically for this project.

Theme	Source and Description	Visible Map Scale in Thousands (gray)												
		15,000	2,000	1,000	500	250	200	150	100	75	50	35	10	0
Bird Outages	EDSA; unplanned, sustained bird-caused outages													
Equipment Outages	EDSA; unplanned, sustained equipment-caused outages													
Tree Outages	EDSA; unplanned, sustained tree-caused outages													
Animal Outages	EDSA; unplanned, sustained animal-caused outages													
Weather Outages	EDSA; unplanned, sustained weather-caused outages													
Unknown Outages	EDSA; unplanned, sustained unknown-caused outages													
Other Outages	EDSA; unplanned, sustained all outages from all other causes													
All Momentary Outages	EDSA; unplanned, momentary outages from all causes													
All Outages (& Report)	EDSA; unplanned, sustained outages from all causes, 1994 – 1998 This theme allows generation of outage report													
All Outages - 97	EDSA; unplanned, sustained outages for 1997 only													
All Outages - 96	EDSA; unplanned, sustained outages for 1996 only													
All Outages - 95	EDSA; unplanned, sustained outages for 1995 only													
All Outages - 94	EDSA; unplanned, sustained outages for 1996 only													
Fuses	EDSA; fuse location													
Switches	EDSA; switch location, open and closed position is shown													
Boosters	EDSA; booster position													
Autoboosters	EDSA; autobooster position													
Capacitors	EDSA; capacitor position													

Theme	Source and Description	Visible Map Scale in Thousands (gray)												
		15,000	2,000	1,000	500	250	200	150	100	75	50	35	10	0
Interrupters	EDSA; interrupter position													
Reclosers	EDSA; recloser position													
Regulators	EDSA; regulator position													
Sectionalizers	EDSA; sectionalizer position													
Stepdowns	EDSA; stepdown position													
Transformers	EDSA; transformer position- type is shown (e.g. overhead, underground, etc.)													
Substations	Pole & Tower maps													
Substation Labels	Pole & Tower maps													
Facilities	Pole & Tower maps													
Facility Labels	Pole & Tower maps													
Foreign Elec. Lines	Various outside sources													
Distribution Lines	EDSA; shows circuit name and number													
All Transmission Lines	Pole & Tower maps line coverage of 60, 70, 115, 230 & 500kV Transmission lines													
Highways	Etak, Inc.													
Major Roads	Etak, Inc.													
Minor Roads	Etak, Inc.													
Other Roads (Forest Srvc.)	Etak, Inc. and other sources													
Railroads	Etak, Inc.													
Division Lines	In house													
Fire History	California Department of Forestry													
Zip Codes	Etak, Inc.													

Theme	Source and Description	Visible Map Scale in Thousands (gray)												
		15,000	2,000	1,000	500	250	200	150	100	75	50	35	10	0
Land-Grants	Teale Data Center													
Township-Range	Teale Data Center													
Sections	Teale Data Center													
7.5' Quads	Teale Data Center													
County Lines	Teale Data Center													
Western Gray Squirrel Habitat	UC Santa Barbara Gap Analysis Program; uses wildlife habitat relationships (WHR) predictive wildlife model for gray squirrel from Calif. Dept. of Fish and Game and classified aerial photography of vegetation.													
Acorn Woodpecker Habitat	UC Santa Barbara Gap Analysis Program; uses WHR predictive wildlife model for acorn woodpecker from Calif. Dept. of Fish and Game and classified aerial photography of vegetation.													
Great-Horned Owl Habitat	UC Santa Barbara GAP Analysis Program; uses WHR predictive wildlife model for great-horned owl from Calif. Dept. of Fish and Game and classified aerial photography of vegetation.													
Golden Eagle Habitat	UC Santa Barbara GAP Analysis Program; uses WHRpredictive wildlife model for golden eagle from Calif. Dept. of Fish and Game and classified aerial photography of vegetation.													
Osprey Habitat	UC Santa Barbara GAP Analysis Program; uses WHRpredictive wildlife model for osprey from Calif. Dept. of Fish and Game and classified aerial photography of vegetation.													

Theme	Source and Description	Visible Map Scale in Thousands (gray)												
		15,000	2,000	1,000	500	250	200	150	100	75	50	35	10	0
California Condor Habitat	UC Santa Barbara GAP Analysis Program; uses WHRpredictive wildlife model for Calif. condor from Calif. Dept. of Fish and Game and classified aerial photography of vegetation.													
CNDDB (& Report)	Calif. Department of Fish and Game, Natural Heritage Division; sensitive plant and animal species and habitats. Report is available.													
Water Features (lines)	Teale Data Center													
Silicon Valley Load Change	In house													
Silicon Valley Load Change (Areas)	In house													
Avg. Annual Precipitation	Various sources; layer represents lines of equal rainfall (isohyets) based on 60-year mean annual precipitation data													
Lightning Strike Density	Global Atmospherics Inc. ; 2.5 Sq. mile grids representing lighting flash density from the period of 1990 to 1996. Layer covers the entire state.													
Historical Peak Wind	In house; Wind contours representing extreme winds based upon 1 minute average wind speed, 33 feet above ground level, over a 50-year return period.													
Water Features (Polygons)	Teale Data Center													

Theme	Source and Description	Visible Map Scale in Thousands (gray)												
		15,000	2,000	1,000	500	250	200	150	100	75	50	35	10	0
DPA Weather Data	In house; report available showing wx station, date, daily low, daily high, 3-day weighted high, peak wind (mph), and avg. wind (mph)													
Distribution Planning Areas	In house													
Population Density	US Census; values extrapolated from 1990 US Census tract population figures based on Department of Finance 1998 county population projects													
Military Lands	Teale Data Center													
Competitors	Combination of Etak and in-house; Electric competitor areas													
Raster Quad	Teale Data Center; 1:24,000 USGS Quadrangle maps													
Cultural Features	Etak, Inc.; Parks, Airports, etc.													
City Polygons	US Census Tiger data													
CA Counties	Teale Data Center													
Divisions	In house													
Hillshade	Teale Data Center													

2.4.4 Electric Distribution Facilities.

These themes were developed primarily from a tabular database called the Electric Distribution System Analysis (EDSA) database. EDSA contains a model of the electric distribution system that includes spatial coordinates for all equipment poles or underground facilities, a spatial representation of above ground and underground circuits, and supporting information about these features. For example, EDSA stores the circuit names and operating voltages, which are then displayed by the map server upon user request. Additional facilities were loaded into the map server from other sources (Table 3).

2.4.5 Electric Distribution Outages

EDSA is also a repository for outage reporting within PG&E. When an unplanned outage occurs, the cause is usually investigated. A troubleman or other inspector determines the details of the outage, the equipment affected, and the cause. This information is recorded in EDSA over the PG&E's computer network at its division offices. This outage information was exported from EDSA and processed for use on the map server.

Through EDSA, PG&E tracks many types of outages, including bird- and animal-caused. Animal-caused outages are distinguished from bird-caused outages and are typically outages caused by squirrels. The location recorded for an outage is at the nearest source-side device that opened the circuit. This device can be a fuse, circuit breaker, recloser, or other similar device that breaks the circuit in response to an unusual load caused by a short. The location of the short or fault is not recorded.

2.4.6 Wildlife Predictive Themes

Users of the pilot study's information tool needed a better way to identify where to implement PG&E's raptor construction standard. This standard calls for 60-inch spacing between phases to protect against brush contacts with eagles. PG&E uses a modified raptor construction method in areas where raptors other than eagles are expected. Because of the wider spacing, the full raptor construction method is more expensive. Consequently, cost savings can be obtained by using this construction in only those areas where eagles are likely to occur.

PG&E developed such a theme for the map server by using predictive wildlife models from the California Wildlife Habitat Relationships (WHR) Program (Airola 1988). These models predict the likelihood of the occurrence of terrestrial vertebrate species as high, medium, or low, based upon vegetation type and structure. The Gap Analysis Program

(Davis et al. 1998) classified the vegetation types for California from satellite imagery. PG&E also included WHR models for other species on the map server. This includes acorn woodpeckers that destroy wood poles, fox squirrels, gray squirrels, and other species that could impact, or be impacted by, the electric distribution system (Table 3).

2.4.7 Sensitive Species

Planning engineers need to know if construction could impact threatened or endangered species. They can get helpful information about these species from a map server theme derived from the California Natural Diversity Database (CNDDB 1999). The California Department of Fish and Game's (CDFG) Natural Heritage Division maintains this database. The CNDDB contains records of known occurrences of sensitive, (including legally protected threatened or endangered) plant and animals species. Sensitive habitats are also included. PG&E receives updates for this information through a subscription with CDFG. Sensitive species locations are shown in the map server as polygons that are color-coded by species frequency. The map server can produce a report of sensitive species details that are contained within a user-specified area.

2.4.8 Land Base

The land base information includes major and minor roads, railroads, waterways, lakes, cities, parks, and ownership themes. The themes were available prior to this project. However, this project included the modification and incorporation of raster U. S. Geological Survey (USGS) quadrangle (quad) maps for PG&E's service area. In addition to the many land base details found on USGS quad maps that were derived from aerial photography, these maps also contain topographic 40-foot interval contour lines that provide planners with useful elevation information.

2.4.9 Map Server Implementation

The server is implemented on a Dell Workstation 400 with dual 300mhz Pentium 2 processors and 256 MB of ram. The datasets occupy approximately 50 GB of hard disk space. A special purchase of hard disks was made for this project, primarily to store the USGS quadrangle raster maps.

Users access the map server application through their Web browsers. PG&E's standard Web browser is Microsoft's Internet Explorer©. Users locate the Web site on PG&E's Intranet by following hyperlinks from the home page. Appendix I replicates a typical session using the map server.

The initial map server page shows a map of PG&E's service area at an initial scale of 1:9,600,000 (approximately) and a legend of available themes at that scale. Users can zoom in to a number of different types of locations (for example, cities, USGS quads, townships, and PG&E distribution planning areas). More themes are available at larger scales (Table 1). A user can return to the same location with the same number of themes displayed by saving a super bookmark for that location. This bookmarked location and format are available to a user in future sessions. The themes initially available to electric distribution planners were chosen for their relevance to their work needs. However, using a "manage layers" function, the user can select a huge variety of themes, such as gas pipelines, electric transmission lines, and ownership boundaries.

Detailed information about many of the mapped features can be presented to a user in the form of pop-up labels, reports and legend-keyed symbols. For example, reports are

available for outage information and CNDDB-sensitive species through user interaction with mapped features.

2.4.10 Wildlife and Powerline Assessment Tool Use and Support

The use of the wildlife and powerline assessment tool has grown steadily following its release in December 1998 (Table 2). Clearly, the target audience for this tool(the Distribution Customer Service business unit) has made the greatest number of hits. An e-mail solicitation for user feedback was sent to all electric planners and estimators in April 1999. Although the number of responses were few, the comments received were extremely positive.

Table 2. Number of Map Server Hits by PG&E Business Unit by Month
(March 22 through June 30, 1999)

Business Unit	March	April	May	June	Total
Corporate Services	45	87	62	167	361
Distribution Customer Service	74	101	129	300	604
Electric Supply	8	27	19	26	80
Electric Transmission		1		6	7
Generation Transmission	3	2	5	4	14
Nuclear Power Generation	4	9	3	14	30
Contractors (various business units)	11	23	19	86	129
Total	145	250	237	603	1235

One way to measure the success of this project was to determine the willingness of PG&E to continue supporting data updates and feature enhancements. In PG&E's cost-conscious business culture, it is difficult for an internal operations organization to commit budget for new methods. However, PG&E's distribution department appears to be willing to support data maintenance of at least the facility information in the near future.

2.5 Conclusions

2.5.1 How This Application Has Changed Work Processes

Since use of the wildlife and powerline assessment tool is increasing steadily, it is reasonable to assume that it will continue to be supported at PG&E for the foreseeable future. PG&E had hoped to show specifically how a distribution electric planner had incorporated its use into planning for a new circuit or circuit upgrade. While this expectation proved to be too ambitious, PG&E did receive encouraging e-mails from planning engineers indicating that the new system is a useful tool that they will probably continue to use in their work. For example, one engineer recently explained how he used the tool to ascertain where bird-caused outages had occurred over the last five years in the Delta area in preparation for adding bird protection devices to equipment poles.

Business units other than the target audience are also taking advantage of the new map server (Table 2). For example, a PG&E vegetation specialist has developed maps from this system that show where distribution circuits are in relation to known sensitive species (from the CNDDB database) for their area of responsibility. PG&E biologists routinely use this system to produce CNDDB maps in relation to PG&E facilities. Prior to the advent of the server, biologists relied primarily on a tabular database output that was difficult to geographically relate to PG&E facilities.

2.5.2 How This Application Addresses the Settlement Agreement

The 1994 settlement agreement between PG&E and the U. S. Fish and Wildlife Service specified that PG&E shall determine where “high risk” areas are for bird electrocution within the service area. The predictive wildlife themes address this need for several species of birds, most notably eagles. In addition, electric distribution planners can interrogate the wildlife and powerline assessment toolfor bird-caused outage history and sensitive species information to determine the most effective wildlife-protective design for the species that are likely to inhabit the project location. PG&E already has an effective construction standard for reducing bird electrocutions, but its implementation can now be guided by interrogation of the map server. Prior to this information, planners had no systematic way to know where the high-risk areas were other than verbal communications with field personnel.

2.5.3 System Enhancements

The concept of the wildlife and powerline assessment tool is relatively new. Following its implementation in December, a number of enhancements have been made for the simple reason that users are beginning to understand its capabilities. For example, historical weather information is now available as a theme for users. Users are just beginning to understand the potential of this system for communicating mapped information. One new idea emerging is to store field data collected by vegetation specialists and biologists as themes that their internal clients could access as needed. For example, PG&E biologists are currently conducting a comprehensive inventory of transmission line access roads and associated sensitive habitats. The map server could

serve as an efficient way to communicate the findings of this work to many client groups throughout the company.

2.5.4 How This Application Could Be Used By Other Utilities

The wildlife and powerline assessment tool application employs an off-the-shelf product that other utilities could use to their advantage. The concepts developed for this project and presented here to address the risk to wildlife could be implemented easily by other California utilities. The predictive wildlife models and sensitive species information in the CNDDB database are available statewide at relatively low cost. Since most utilities track outages by cause, this information could be used in the same manner as it was in this study.

2.5.5 How the Research Helps Meet the PIER Program Objectives

The project met 3 of the PIER program: Increase the reliability of the electric system, Reduce the environmental impacts of electricity generation, distribution, and use, and Advance science and technology not provided by competitive and regulated markets. The reliability of the electric system is expected to improve where protection measures are implemented to reduce wildlife-caused outages. Enhance California's economy was met indirectly. The wildlife and powerline assessment tool should help guide planners to locate the areas within PG&E's large service area where such measures would be best implemented. By reducing the number of wildlife caused outages, is also achieved by reducing the incidence of wildlife electrocutions. The wildlife and powerline assessment tool implementation at PG&E was also met by advancing the science and technology of using GIS over the intranet with a unique combination of wildlife-related themes combined with utility facility information.

2.6 Recommendations

2.6.1 Training

Currently, the greatest need is for training in, and exposure to, the new wildlife and powerline assessment tool. PG&E's electric distribution planners and engineers should be provided the opportunity to become familiar with the various features of the tool. Training modules should be developed using classroom presentations, videos, and computer-based training. The Help features of the system should also be improved. Currently, experimentation is the best way to become familiar with its capabilities. Specific training tutorials would be an effective way to familiarize users with the map server's capabilities.

2.6.2 Data Maintenance

Periodic updates are needed to keep the data themes current. For example, electric distribution outage information should be updated at least monthly to provide users with current information. PG&E receives updates to the CNDDB sensitive species database every six months. Updates of this information should occur at the same time. The greatest challenge to making these updates is finding the budget for the several days needed to perform the updates. Providing the dollars for these updates should be a priority for PG&E's distribution department.

2.6.3 Technology Transfer to Other Utilities

The California Energy Commission could sponsor training to enable other utilities to become familiar with the concepts of the wildlife and powerline assessment tool and how to best implement the features developed by this project. This training could be performed either through presentations, videos, or through the Internet.

3.0 Wildlife Devices

3.1 Introduction

This study examined the condition of wildlife protective devices installed on PG&E's electric distribution system. These devices either insulate or otherwise protect wildlife from contacting energized equipment. Such contact can result in electrocution of wildlife species and an electrical outage to the distribution system. However, the wildlife protection devices have a limited lifetime. The materials are subject to exposure and will degrade over time. At some point they may fail and either become ineffective at best or cause an outage or other system failure at worst. This study aimed to better understand the lifetime of effectiveness of these devices.

This study was performed by Ed Colson of Colson and Associates. This section was provided by Colson and Associates. Text in the first person (e.g., I, we,) refers to Colson and Associates.

3.2 Need For Wildlife Deterrent Technology

Birds and other animals are the fourth leading cause of electric distribution outages in the PG&E system (CES 1997). Overhead electric distribution and transmission facilities pose an electrocution and / or collision hazard to wildlife and compromise system reliability. Common methods for reducing potential wildlife-caused outages and mortalities on existing electric facilities industry-wide is to reconfigure poles to increase phase separation or apply add-on insulation (for example, bushing covers, wire insulation), or deterrent products (for example, perch guards, electrostatic guards) to exposed or nearby energized surfaces. These add-on products are commonly referred to as wildlife protective devices.

In response, PG&E developed its first, *Raptor-Protected Primary Construction, Wood Pole Distribution Lines*, Engineering Standards in 1983 (PG&E 1983). As more knowledge was gained, these standards were revised. PG&E's October 1, 1998 revised standards include many more options for line configurations and the use of add-on devices designed to deter or insulate wildlife from electrical components (PG&E 1998).

Like many other electric utility companies throughout most of North America and Canada, PG&E has installed wildlife protective devices as a cost-effective solution for minimizing electrical outages and associated bird / animal mortalities. However, to date, we know of no utility that has examined the efficacy of these products in the field. This research sought to better understand current wildlife-deterrent technology, the expected life span of equipment, installation techniques and areas requiring improvement.

PG&E has modified hundreds of poles to increase phase separation, and has installed thousands of wildlife protective devices on distribution poles and related facilities in its service area. Despite these efforts, wildlife-caused outages in the PG&E service area have risen at a rate of eight to nine percent annually over the last decade. Part of the rise in wildlife-outages may be attributable to the proliferation of local species, such as starlings or squirrels, which increase the risk of electrical outages on powerlines. Another contributing factor may be that PG&E now places greater emphasis on the

investigation of all reported outages, thus reducing the number of unknown incidents. In either case, there is a critical need for the investigation of devices / products installed in the field to ensure that remedial steps now being taken are appropriate and to identify products or installation procedures that may be contributing to increased wildlife-related outages.

In the last few years, PG&E has identified some add-on wildlife protective products that have degraded in the field. We believe that the oldest products (for example, bushing covers and jumper insulation) have been in the field for at least 18 years. PG&E conducted accelerated aging tests on a variety of wildlife protective devices at PG&E's Technical and Ecological Services (TES) in 1997. These laboratory tests show some insulation products are susceptible to degradation caused by various environmental factors such as moisture, sunlight, and contaminates (PG&E 1999 In press). Some products experienced a rapid degradation of mechanical and electrical characteristics in laboratory tests. Our current research identifies and examines the condition of these same products and other wildlife protective products installed in actual field conditions. Results of years of field installation procedures and practices were also examined. Our overall goal was to determine why bird and animal-caused outages continue to increase, while many efforts are being employed to reduce these outages.

3.3 Methods

3.3.1 Records Review

Beginning in June, 1998, we reviewed the literature on wildlife protective devices currently used within the industry , and specifically within PG&E. We also examined PG&E's databases to gather historical data on equipment purchased and the location of wildlife-caused outages. We queried the PG&E *Facility Assessment Condition Tracking System* (FACTS) and *Material Problem Reports* (MPR) to identify manufacturers, installation dates, location of products in the field, and add-on devices installed that could be problematic.

3.3.2 Division Contacts

E-mail inquiries were distributed to all 18 divisions to identify current wildlife protective devices installed within the service area. These inquiries were made of PG&E's Senior Division Planning Engineers and Overhead Maintenance & Construction (OM&C) personnel from each division to identify additional devices purchased, approximate quantities, installation dates, and location. We used these records and division contacts to locate circuits and poles during its field investigations.

3.3.3 Field Investigations

In consultation with Dr. Harrison Stubbs, Biostatistical Consultant, we attempted to determine a degree of failure for add-on wildlife protective devices. We wanted to know how many of a particular device would have to be found in the field to put confidence intervals around a failure rate. Data were unavailable on how many devices of any type were actually installed, or their location before going into the field. We eventually

selected six divisions for field investigations based upon FACTS tags, Division e-mail responses, geographic conditions, number and variety of devices installed, importance of the devices, and historic wildlife-caused outages.

Prior to conducting field investigations, we developed a pictorial database that allowed quick and easy identification of manufactured products seen in the service area. A field data sheet was prepared to record the date, circuit name, location, wildlife protective device(s) and condition, adjacent land use, pole type, installation practices, and pole number (Appendix A). Field investigations were performed using an automobile, binoculars, and camera to examine installed wildlife protective devices within selected divisions. We drove to specific circuits suggested by division representatives and identified in the FACTS database to search for poles with devices. Poles were inspected if they had at least *some* wildlife protective equipment visible from the ground. After locating poles, they were inspected from the ground with binoculars and a spotting scope. We completed data sheets and photographed all poles inspected.

PG&E's primary objective was to determine the condition of installed wildlife protective devices. During preliminary investigations, it became apparent that although many installed devices were relatively new, there were some installation problems. In addition, PG&E had begun to remove various aging wildlife protective equipment that had been problematic (Pers. comm. 1999, C. Poston). With increased awareness and revised engineering standards that offer more options, many PG&E divisions were installing a variety of newly PG&E cataloged and uncataloged devices. Therefore, our field investigations focused not only on the physical condition of wildlife protective devices, but on installation practices.

3.4 Outcomes

3.4.1 Records Review

We obtained a summary report from PG&E's Materials Department that identified PG&E coded wildlife protective devices purchased, quantities, and suppliers from the period August 1996 to October 1998 (Table 3). Earlier records of purchased devices were not readily available.

Table 3. Wildlife Protective Devices Purchased by All Divisions
(Aug 1996-Oct 1998)

Device	Number of Units	PG&E Code Numbers
PVC tubing	129,721	M 382126
Salisbury Lead Wire Cover (tubing)	55,224	M 018205
Moloney Cover	49,208	M 267685
Squirrely Cover	11,553	M 267855
Lineway Cover	10,495	M 018204
Salisbury Bare Wire Cover (tubing)	6,829	M 018206
Fargo Cover	5,050	M 261862
Guthrie-Regular (Electrostatic guard)	2,739	M 261267
Bird Flight Diverter-Small	924	M 560327
Conductor Spacer (Crossarm construction)	350	M 185161
Bird Flight Diverter-Large	224	M 560328
Conductor Spacer (Single Phase construction)	128	M 185160
Conductor Spacer (Triangular construction)	120	M 185162
Guthrie-Large (Electrostatic guard)	30	M 261302

We sorted the data by division and product. To gain a better perspective on the type and quantity of protective devices installed within PG&E, we computed the ratio of each of these devices to actual line miles found within each division (Appendix II). PG&E assumed that most of the devices purchased were eventually installed.

Data suggest that the most abundant devices found in the field would be:

- PVC covering (tubing) at 4.6 units per line miles in Fresno Division
- W.H. Salisbury bare wire covers (tubing) at 3.5 units per line mile in San Francisco Division
- Squirrely covers at 1.6 units per line mile in De Anza Division
- Salisbury line wire covers (tubing) at 1.5 units per line mile in Yosemite Division

- Moloney covers at 1.3 units per line mile in the Fresno Division.

Based on the above, wildlife protective devices are not yet abundant in the PG&E service area.

The protective devices that the Materials database recorded as being purchased most often and their respective manufacturers are: PVC Insulation Covering (tubing) (Scott Engineering), Salisbury Line Wire Cover (tubing) (W. H. Salisbury & Co.), Moloney Cover (Central Moloney Corp.), Squirrely Cover (distributed by H. J. Arnett Industries), Lineway Cover (Lineway Corp.), and Salisbury Bare Wire Cover (tubing) (W. H. Salisbury & Co).

Table 3 lists these devices. Recent purchases include Fargo Cover (Fargo Manufacturing Co.), Electrostatic Bird / Animal Guard (Guthrie Corporation), Conductor Spacer (Continental Electric Co.), and Bird Flight Diverter (Dulmison Corporation). These more recently purchased devices are apparently not yet in widespread use at PG&E. An old-style PVC bushing cover manufactured by H. J. Webb Company was not identified in the database, but was found in the field. Although not numerous, the PVC bushing covers were apparently widely distributed throughout the service area in the past. Also, triangular perch guards were not found in the database, but were observed in the field.

We queried the *Material Problem Reports* (MPR) database to determine which wildlife protective devices were reported. This company-wide program tracks defective equipment or material found in the gas and electric transmission and distribution systems, thereby identifying failure trends, improving quality, influencing purchasing decisions, increasing safety, correcting undesirable operating or installation procedures, and providing early warning problem areas (DCS 1998).

PG&E examined data available from March 16, 1994 to November 25, 1998 to locate any wildlife protective devices that were reported to have failed in service. We searched the MPR database for all PG&E coded materials associated with bushing covers, electrostatic animal guards, wire covers and tapes, conductor spacers, perch guards, squirrel wrap (vinyl pole wrap), and bird flight diverters (BFDs). We found four records associated with wildlife protective devices.

The four records involved flashover or tracking associated with Central Moloney bird guards, PG&E Code #267685. Since few records were found, it can be assumed either that there are few problems with much of this equipment, or that problems are not being reported. While bushing covers, insulated wire, and insulated tubing for wire from a limited number of manufacturers have been in use for many years within PG&E, the use of perch guards, squirrel wrap, electrostatic animal guards, and bird flight diverters is relatively new. TES has received some wildlife protective covers, for example,. Central Moloney & H. J. Webb Co. covers that have failed in the field and apparently caused electrical outages (Pers. comm. 1998, M. Dedon).

We also examined the *Facility Assessment Condition Tracking System* (FACTS) database for records pertaining to wildlife associated with overhead electrical distribution equipment. This company-wide program seeks to identify, report and track maintenance conducted on distribution electrical equipment. We identified records associated with

wildlife-related maintenance for the period from May 20, 1993 to December 29, 1998. The maintenance request forms (tags) completed by field personnel usually recommend raptor protection (modified construction techniques), installation of bird or animal guards, and insulation of jumpers along particular circuits or poles. Reviewing these remarks and dates of completion helped us to identify particular circuits and equipment poles for study during field investigations.

3.4.2 Division Contacts

All divisions reported modified construction techniques or the purchase and installation of some form of wildlife protection. Typically, divisions do not record the precise location and quantity of wildlife protective devices installed. Further, PG&E does not require tracking of the installation of small components and subassemblies on its distribution system. However, some divisions such as: Diablo, Central Coast, Kern, North Bay, North Coast, North Valley, San Jose and Sierra did report installing numerous protective devices.. Several divisions referred the researchers to the FACTS database for the location and relative quantity of devices installed.

Those divisions that provided specific product and location data helped researchers select sites for field investigations. Some products we observed in the field were not in any known database. They include wildlife protective covers manufactured by Custom Plastics (PG&E Code #560371), Eritech (not coded), and Raychem (PG&E Code #560370), Vinyl Pole Wrap or “Buzzline Woodpecker Shields” (PG&E Code #560338) from Warren Heim Corporation and Triangular Perch Guards, which were home-made of polyvinyl chloride (PVC).

3.4.3 Field Investigations

Locations Investigated. The following six divisions were selected for field investigations: Central Coast, Diablo, Fresno, Los Padres, Sierra, and Yosemite. While we did obtain a cross section of all known types of equipment poles that contribute to most wildlife interactions throughout the PG&E service area, we inspected a relatively small number of poles that probably do not represent the entire distribution system. There are approximately 2.2 million poles in the electric distribution system. We examined 253 poles that support ten different types of equipment. As stated earlier, only poles with some wildlife protective device visible from the ground were examined. The most poles found of a particular type with wildlife protective devices were: cutout riser (62, or 24.5 percent), single phase transformer (54, or 21.3 percent), two-transformer bank (42, or 16.6 percent), recloser (25, or 10 percent), tangent (22, or 8.7 percent), three phase transformer (18, or 7.1 percent) and capacitor bank (15, or 5.9 percent).

Table 4 summarizes the number and type of equipment poles inspected within selected PG&E divisions.

Table 4. Number and Type of Equipment Poles Inspected within Selected PG&E Divisions

Pole Type	Central Coast	Diablo	Fresno	Los Padres	Sierra	Yosemite	Total Poles	Percent Poles
Capacitor Bank	2	6	1	5	1	0	15	5.9
Corner Pole	3	0	0	0	0	3	6	2..4
Cutout Riser	5	10	22	2	23	0	62	24.5
Recloser	4	3	4	3	11	0	25	9.9
Sectionalizer	0	1	0	0	0	0	1	0.4
Single Phase Transformer	1	16	9	18	5	5	54	21.3
Tangent	0	0	0	0	22	0	22	8.7
Three Phase Transformer	1	0	4	4	5	4	18	7.1
Two Transformer Bank	1	3	19	10	8	1	42	16.6
Voltage Regulator	1	2	0	1	4	0	8	3.2
Total	18	41	59	43	79	13	253	100

3.4.4 Devices Found During Field Investigations.

During field investigations we inspected 432 wildlife protective devices on 253 poles (Table 4). Many poles contain both bushing covers and insulated wire or bushing covers and jumper insulation. We found devices from at least 16 different manufacturers. The devices most common on all poles inspected were: W.H. Salisbury jumper insulation (154 poles), Moloney bushing cover (98 poles), and insulated wire (33 poles). These particular devices were found in at least five of the six divisions we investigated. Insulated wire was grouped into one category because differences in manufacturers could not be determined from the ground. Cooper covers (12 poles), which are factory installed and found on most Capacitor Banks, were inspected in four divisions, but they exist in all divisions. Webb covers (7 poles) were found within 2 divisions, Diablo and Sierra. The Moloney, Webb and Lineway covers (4 poles) are some of the oldest protective devices installed in the PG&E system. Squirrely covers (39 poles) were found in 4 divisions. Many poles in the Sierra Division were found with newly installed Fargo covers (37 poles), and newly installed Eritech covers (6 poles) were found only in Diablo Division. Sierra Division is conducting field tests for many of these wildlife protective devices which would contribute to their having greater numbers of some devices. Bird flight diverters, electrostatic guards, perch guards, vinyl pole wrap and mid-span spacers are relatively new. Thus they were found in only a few locations.

3.4.5 Degraded Devices.

Of the 253 poles we examined, 80 poles (32 percent) were found with degraded devices. The type of degradation observed, ranked from least to most, was discoloration (for example, ultra-violet light damage), black traces, tracking and / or erosion, tearing (caused by wear) and deformation. PG&E anticipates that those devices showing discoloration or black traces would have a greater likelihood of performing as they were designed, while those devices showing obvious tracking / erosion, tearing, or deformation would have lost some of their designed functionality (Pers. comm. 1999, T. Bialek). Consequently, we grouped the results into Classes A and B to represent these less severe (discoloration or black traces) and more severe (tracking / erosion, torn, or deformation) forms of degradation, respectively. This ranking of degradation severity is based only on what we could observe of the device's condition from the ground. A closer examination could reveal other clues that would indicate greater or lesser degradation. For example, tracking could occur on the inside surface of a device that only appeared discolored on the outside surface.

Class A - Degradation that is of a lesser degree such as discoloration or black traces that will not likely affect performance.

Class B - Degradation of a greater degree which will likely result in reduced performance such as tears, signs of tracking / erosion, or deformation.

Of the 253 poles inspected, 91 Class A degraded devices were found on 69 poles (Table 4). Some poles contained more than one degraded device. More than 50 percent of the inspected poles in Yosemite, Central, Coast and Diablo Divisions showed Class A degradation. Thirty-seven Class B degraded devices were found on 28 poles (see Table 4). Class B degraded devices were found on more than 50 percent of the inspected poles in the Central Coast Division only.

Six different device types showed evidence of Class A degradation and five of these types also showed Class B degradation (). Class A degradation was most often seen on the Webb, Maloney and Cooper Covers (57 percent, 52 percent, and 42 percent, respectively). While Class B degradation was observed mostly on Moloney covers (31 percent). We found no signs of degradation on Bird Flight Diverters, Custom Plastics covers, Eritech covers, Fargo covers, Lineway covers, mid-span spacers, vinyl pole wrap, electrostatic guards and insulated wire.

Table 5. Number and Type of Wildlife Protective Device Found on Equipment Poles Inspected in Six Divisions

Device	C. Coast	Diablo	Fresno	Los Padres	Sierra	Yosemite	Total [1/]
Bird Flight Diverter	0	0	0	0	15	0	15
Cooper Cover	2	0	3	4	3	0	12
Custom Plastics Cover	0	4	0	0	0	0	4
Eritech Cover	0	6	0	0	0	0	6
Fargo Cover	0	0	0	0	37	0	37
Guthrie Guard	0	5	0	0	1	0	6
Insulated Wire	1	7	9	4	12	0	33
Lineway cover	0	0	4	0	0	0	4
Mid Span Spacer	0	0	0	0	0	7	7
Moloney Cover	9	11	33	29	11	5	98
Perch Guard	1	0	0	0	0	2	3
Salisbury Cover	5	1	0	0	0	0	6
Salisbury Insulation	15	20	42	27	37	13	154
Squirrely Cover	0	12	20	2	5	0	39
Vinyl Pole Wrap	0	1	0	0	0	0	1
Webb Cover	0	6	0	0	1	0	7
Total Devices Inspected	33	73	111	66	122	27	432
Total Poles Inspected	18	41	59	43	79	13	253

[1/] Some poles have more than one type device installed, such as bushing covers used with jumper insulation and bushing covers used with insulated wire.

Within the Class A observations, discoloration was observed on 60 poles (22 percent of the 253 poles inspected) and 31 poles (12 percent) showed black traces on the wildlife protective devices (Table 6). Among the Class B observations, tracking and / or erosion was observed on the devices installed on 18 poles (7 percent), torn devices were found on 12 poles (5 percent), and deformed devices were found on only 5 poles (2 percent). Examples of these forms of degradation are shown in Appendix III, *Selected Photos of Degraded Wildlife Protective Devices.*

Table 6. Number of Degraded Wildlife Protected Devices within Six Divisions

Division	Number of Poles Inspected	Class A Degraded Devices [1/]		Class B Degraded Devices [1/]	
		Number	Percentage	Number	Percentage
Central Coast	18	13	72%	10	56%
Diablo	41	26	63%	7	17%
Fresno	59	11	19%	4	7%
Los Padres	43	14	33%	5	12%
Sierra	79	16	20%	11	11%
Yosemite	13	11	85%	0	0%
Total	253	91	36%	37	15%

Table 7. Number and Type of Degraded Wildlife Protected Devices/Products Found on 253 Poles within Six Divisions

Device	Central Coast		Diablo		Fresno		Los Padres		Sierra		Yosemite		Total Poles w/ Device	Total Poles	
DeviceClass[1/]->	A	B	A	B	A	B	A	B	A	B	A	B		A (%)	B (%)
Squirrely Cover	0	0	1	1	0	0	0	0	0	0	0	0	39	1 (30%)	1 (3%)
Cooper Cover	3	0	6	0	0	0	2	1	0	0	0	0	12	5 (42%)	1 (8%)
Moloney Cover	5	6	20	5	6	4	7	4	12	11	1	0	98	51 (52%)	30 (31%)
Salisbury Cover	4	4	1	0	0	0	0	0	0	0	0	0	39	5 (13%)	4 (10%)
Salisbury insul.	1	0	0	0	5	0	5	0	4	0	10	0	154	25 (16%)	0 (0%)
Webb Cover	0	0	4	1	0	0	0	0	0	0	0	0	7	4 (57%)	1 (14%)

[1/] Class A device shows signs of discoloration or black traces. Class B device shows signs of tracking / erosion, torn, or deformed.

Table 8. Number and Condition of Degraded Wildlife Protective Devices Found on 80 Poles Within Six Divisions

Product	CONDITION[1/]				
	CLASS A		CLASS B		
	Discoloration	Black Traces	Tracking/Erosion	Torn	Deformed
Central Coast Division					
Moloney Cover	3	2	2	2	
Salisbury Insul.	1	0	0	0	
Cooper Cover	2	1	0	0	
Salisbury Cover	4	0	3	1	
Total Poles [2]/	10	3	5	3	
Diablo Division					
Moloney Cover	11	9	4	0	
Squirrely Cover	1	0	0	1	
Salisbury Insul.	0	0	0	0	
Insulated Wire	0	0	0	0	
Webb Cover	1	3	1	0	
Salisbury Cover	1	0	0	0	
Total Poles[2]/	14	12	5	1	
Fresno Division:					
Moloney Cover	3	3	1	3	
Salisbury Insul.	5	0	0	0	
Insulated Wire	0	0	0	0	
Total Poles[2]/	8	3	1	3	
Los Padres Division					
Moloney Cover	4	3	2	2	
Salisbury Insul.	1	4	0	0	
Cooper Cover	1	1	1	0	
Total Poles[2/]	6	8	3	2	
Sierra Division					
Moloney Cover	7	5	4	3	
Salisbury Insul.	4	0	0	0	
Insulated Wire	0	0	0	0	
Total Poles[2/]	11	5	4	3	
Yosemite Division					
Moloney Cover	1	0	0	0	
Salisbury Insul.	10	0	0	0	
Perch Guard	0	0	0	0	
Total Poles[2/]	11	0	0	0	
Grand Total	60	31	18	12	

[1/] Definitions:

Class A =

- Discoloration-visual signs of yellowing or bleaching on exterior surface of bushing cover or jumper insulation, usually caused by ultraviolet light damage.
- Black Traces-visual signs of black smudges on exterior surface of bushing cover or tubular jumper insulation.

Class B =

- Tracking and/or erosion- visual signs of black spider-web-like designs that in an advanced state may also include loss of material at leading edges of bushing cover or jumper insulation.
- Torn-visual signs of an irregular tear that may have resulted from undue strain, vibration or product failure.
- Deformed-visual signs of a misshapen device. May be wrinkled, twisted, or otherwise irregular in shape.

[2/] A pole is counted once, regardless of how many devices it contains; also, most poles contain more than one device.

Environmental conditions may lead to device degradation. Therefore, we recorded land use conditions, contaminants and the relative amount of solar exposure observed near each pole inspected (Table 9).

Table 9. Land Use, Contaminants, and Solar Exposure Observed near Selected Poles with Degraded Wildlife Protected Devices

	Central Coast	Diablo	Fresno	Los Padres	Sierra	Yosemite	Total	Percent
Land Uses:								
Agriculture	0	0	1	6	0	4	11	13.6
Residential	6	20	11	3	10	0	50	61.7
Commercial	2	1	1	1	0	0	5	6.2
Wetlands	0	0	0	0	0	7	7	8.6
Woodland	2	0	0	0	1	0	3	3.7
Grassland	1	1	0	0	0	0	2	2.5
Orchard/vineyard	0	0	0	1	2	0	3	3.7
Total	11	22[1/]	13	11	13	11	81[1/]	100.0
Contaminants:								
Exhaust	5	9	11	8	2	0	35	43.2
Chemicals	0	0	0	0	0	0	0	0
Dust	0	1	0	0	0	0	1	1.2
None	6	12	2	3	11	11	45	55.6
Total	11	22[1/]	13	11	13	11	81[1/]	100.0
Solar Exposure:								
Full	11	21	13	11	12	11	79	99
Partial					1		1	1
Total	11	21	13	11	13	11	80	100
Total Poles Inspected	11	21	13	11	13	11	80	100

[1/] Totals do not match total poles inspected, because the pole site contained more than one land use category or contaminant.

Most poles inspected (50 poles or 61.7 percent) were found in residential areas. Heavy auto exhaust was associated with 35 poles inspected (43.2 percent) and full sun exposure was found in the vicinity of 79 out of 80 poles inspected (99 percent). Since the sample is small and some older devices have been removed, PG&E were unable to make any correlation between environmental conditions and degradation of devices.

Historical records show PG&E purchased and installed wildlife-protective devices from as early as 1983. Bird guards (bushing covers) were recommended on Capacitor bushings since 1981 (PG&E 1981). Without specific records, it is impossible to determine the age of most installed equipment. Generally, we know Moloney covers, Lineway covers and Webb covers were purchased and coded by PG&E as early as 1983 (PG&E 1983). These covers are made from the same base material, poly vinyl chloride (PVC), with few additives.

3.4.6 Poles with Incomplete or Improperly Installed Devices.

As stated earlier, we found poles with devices that were not installed according to manufacturer recommendations or PG&E Engineering Standards. In this report, PG&E assumes that installation is incomplete when bushing covers and jumper insulation are not installed on all energized phases that may pose a risk for a wildlife-caused outage. Complete installation must include both bushing covers and insulated jumpers. Improper installation means that wildlife protective devices are not installed according to PG&E standards or manufacturer recommendations or are incorrectly cut, or otherwise modified to fit.

Poles with incomplete or improperly installed devices pose an ongoing risk for a wildlife-caused outage. While improper installations may lower the risk, the potential for an outage still exists as does an increased risk of other problems. For example, a bushing cover that was installed over more than the top skirt of an insulator could compromise the insulator, resulting in a flashover.

Table 10 provides a summary of poles found with incomplete or improperly installed devices.

Table 10. Number of Poles Found with Incomplete or Improperly Installed Wildlife Protective Devices within Six Divisions

Division	Number of Poles Inspected	Number of Poles with Incomplete or Improperly Installed Devices [2/]	Percent Poles with Incomplete or Improperly Installed Devices
Central Coast	18	11	62
Diablo	41	32	79
Fresno	59	43	73
Los Padres	43	25	59
Sierra	79	42	54
Yosemite	13	12	92
Total	253	165	65

[2/] A pole was counted once, regardless of how many devices were installed improperly.

Table 11 distinguishes incomplete from improper installations.

Table 11. Incomplete versus Improper Installations Found within Six Divisions

Division	In-complete Jumper Insulation	Cover Missing	Cover above Bush Mnt. C/O	Cover Cut	Two Covers / Bushing	Cover Over Many Skirts	Cover Loose	Electro-static Guard Below First Skirt	Perch Guard Miss-placed	Total [1/]
Central Coast	9	4	2	0	0	0	0	0	0	15
Diablo	9	9	1	0	0	7	5	2	0	33
Fresno	20	30	2	1	0	2	3	0	0	58
Los Padres	11	16	0	2	0	1	1	0	0	31
Sierra	20	12	0	0	2	9	1	0	0	44
Yose-mite	7	6	2	0	0	0	0	0	2	17
Total	76	77	7	3	2	19	10	2	2	198
Percent	38.4	38.9	3.5	1.5	1.0	9.6	5.1	1.0	1.0	100.0

[1/] These numbers will not match total poles inspected with installation problems (165), because some poles have more than one type of device installed.

At least 165 out of the 253 poles (65 percent)inspected had incomplete or improperly installed devices (see Table 8). Of the poles inspected, Yosemite Division had the most poles, with 12 out of 13 (92 percent) having incomplete or improperly installed devices, followed by Diablo with 32 out of 41 (79 percent), Fresno Division with 43 out of 59 (73 percent), Central Coast Division with 11 out of 18 (62 percent), Los Padres Division with 25 out of 43 (59 percent), and Sierra Division with 42 out of 79 (54 percent). The most common problem found on 77 poles (38.9 percent) was bushing covers were not installed on all vulnerable equipment bushings- particularly potheads, lightning arresters, and transformer bushings(). Incomplete jumper insulation was the second most common observance on 76 poles (38.4 percent).

We found incidents of bushing covers pushed down over several skirts (19 poles or 9.6 percent) and electrostatic guards installed several skirts below the first and second skirt of the bushing (2 poles or 1.0 percent). According to PG&E Standard #061149, bushing covers and electrostatic guards should be installed between the top two skirts on the bushing. Some covers, such as the Squirrely did not fit properly when existing jumper wires were relatively short. When installed on short jumpers, they tend to open at the side, exposing the jumper connection.

We also found some unusual incidents such as bushing covers installed along jumpers above bushing-mounted cutouts (7 poles, or 3.5 percent), bushing covers and electrostatic guards installed on the same bushing (2 poles, or 1.0 percent), and two different covers (Fargo & Salisbury) installed on the same bushing (2 poles, or 1.0 percent). See Appendix IV, *Selected Photos of Improperly Installed Wildlife Protective Devices*.

3.5 Conclusions

3.5.1 Records

We found that the largest number of devices purchased were not necessarily abundant on the poles inspected. However, Moloney covers, Squirrely covers, and Salisbury bare wire covers, which were the most purchased devices, were found in most divisions investigated.

Only four reports on Moloney covers were found in the Material Problem Reports (MPR). However, Technical and Ecological Services (TES) has received many failed devices over the years. Either fewer such products are failing in the field as suspected, or field personnel have not completed reports. Unfortunately, not reporting wildlife protective devices that fail often results in less awareness and reduces the ability to replace inferior products in a timely manner.

The Facility Assessment Tracking System (FACTS) provided useful information on the location of prescribed devices and pole modifications. However, by design, it does not indicate what was done at completion. Therefore, we were not able to determine what particular devices were installed on which pole and on which equipment until the visit to the circuit.

3.5.2 Division Contacts

We derived some useful information from divisions on the type, quantity and location of wildlife-protective devices installed. However, most divisions do not record this type of information, as it is not required for these and other small components. Traditionally, PG&E has not considered it cost-effective to track installation of millions of small equipment items such as wildlife protective devices (Pers. comm. 1999, W. Gibson).

3.5.3 Field Investigations

We examined 253 poles found within six divisions. We inspected ten different types of equipment poles, including capacitor bank, corner pole, cutout riser, recloser, sectionalizer, single-phase transformer, tangent, three-phase transformer, two-transformer bank, and voltage regulator. Most poles of a particular type with wildlife protective devices were equipment poles such as cutout riser, single phase transformer, two transformer bank, recloser, three phase transformer, and capacitor bank.

The wildlife protective devices found most often on all poles inspected were Salisbury Insulation, Moloney covers, Squirrely covers, Fargo covers, and Insulated wire (General & Republic). Certainly, many poles contain more than one type of device. It was common to see covers and insulated jumpers or covers and insulated wire used together

on the same pole. We found at least 16 different manufacturers of wildlife protective devices in the field.

As expected from purchase records, Moloney covers, Salisbury jumper insulation and insulated wire were found most often. Newer devices, such as Fargo covers, bird flight diverters, electrostatic guards, vinyl pole wrap, and mid-span spacers were found on selected poles usually concentrated in a particular division or section of a division. The varied use of different devices could be partially due to the lack of industry information on each product's ability to prevent wildlife incidents in actual field installations and long-term performance of materials and individual design.

3.5.3.1. Degraded Devices

It appears that the oldest devices purchased by PG&E have experienced the most degradation, although was unable to verify installation dates. Many older wildlife protective devices are apparently being removed (Pers. comm. 1999, C. Poston). It is believed these older products are made of polyvinyl chloride (PVC) and contain fewer ultraviolet light inhibitors. They are expected to degrade sooner than currently available products.

However, some manufacturers such as Central Moloney manufacture both PVC and polypropylene wildlife protective devices, and it is impossible to identify the material composition of the installed device from ground observations. After inspecting 253 equipment poles with wildlife protective devices, we found:

- 91 degraded devices on 69 poles with Class A degradation such as discoloration or black traces
- fewer degraded devices (37) on 28 poles with Class B degradation such as tracking / erosion, tears, or deformation
- Class A degraded devices on more than 50 percent of the inspected poles in three of the six divisions visited.

These numbers may be conservative since our ability to detect degrading devices was limited. Although we used binoculars and a spotting scope, we inspected all poles from the ground and was unable to get closer than the height of the pole. It is possible that a product that appeared sound visually could fail before another product that was ranked as being further degraded. Additionally, a product can fail quickly even though there is no visual sign of damage; in some instances, installation problems can accelerate the failure of a particular product (Pers. comm. 1999, T. Bialek). We identified environmental factors that may contribute to degradation of devices. Land use, potential contaminants, and solar exposure were recorded in the vicinity of all poles inspected. However, the small sample size precludes our ability to draw any inferences from these possible causative factors.

Independent laboratory tests conducted by TES in 1997 show PVC products perform poorly compared to similar products made from other base materials, such as polypropylene copolymers, ethylene propylene diene methylene (EPDM), and silicone

rubber (PG&E 1999, In press). Although improved PVC products are still in use within the industry, many manufacturers use other base materials and include proprietary chemical additives to reduce corona and ultraviolet light degradation (Clabburn et al. 1972; Torok 1989).

According to published sales data, the life expectancy of current manufactured devices ranges from 15 to 20 years. The life expectancy of earlier manufactured devices is anticipated to be much shorter, since most current products / devices contain better ultraviolet light inhibitors, and other proprietary additives. It is our preliminary conclusion that age and chemical composition are the leading factors affecting the degradation rates of wildlife protective devices we are seeing.

3.5.4 Installation Practices

One hundred and sixty-five out of 253 poles (65 percent) were found to have incomplete or improperly installed wildlife protective devices. Investigators found incomplete insulation on 76 (30 percent) and improper installation on 122 (48.2 percent) of the inspected poles. Combined, this is more than twice the number of poles with degraded devices.

Most poles (38.9 percent) had one or more covers missing, and 9.6 percent had covers placed over too many skirts. Previous studies showed that when perch deterrent devices are installed on identified preferred poles, birds moved to what appear to be unsafe areas on the same pole (Colson & Associates 1995). On poles associated with wildlife-caused outages, it is crucial that all areas of potential bird or animal contact with energized electrical equipment be insulated. We found covers pushed down over several skirts, covers placed needlessly above bushing mounted cutouts, and two different covers placed on the same bushing.

We also discovered electrostatic guards placed below the first and second skirt. Some bushing covers were intentionally cut to allow for the jumper wire, and several other new covers, such as the Fargo, and old covers, such as the Moloney, were secured with black electrical tape or nylon ties. Apparently, when protective devices were first installed, only a few models and designs were available, somany devices were made to fit even though they were not the right size for the particular bushing (Pers. comm. 1999, C. Poston).

We questioned both the durability of electrical tape and nylon ties and the need for them. According to manufacturers, when sized properly, bushing covers and jumper insulation do not need to be secured with tape or ties. Cutting bushing covers and tines of electrostatic devices is recommended by some manufacturers for custom installations. However, such modifications may adversely affect the overall ability of these products to function as designed.

We found wildlife protective devices that had not been installed in accordance with manufacturers specifications or PG&E's current *Raptor-Safe Construction and Wildlife Protection Distribution Pole Lines #061149* Revised Engineering Standards (PG&E 1998). Obviously, many of these devices were installed prior to the publication of these new standards. It appeared that the issue of improperly or incompletely installed wildlife

protective devices is not unique to PG&E. Similar problems have been observed in other utilities' service areas throughout North America and Canada. Field personnel appear to be lack of an understanding of the specific interactions of wildlife with electrical utility facilities.

3.5.5 Other Divisions

The preliminary field investigations revealed that some installed wildlife protective devices have degraded, but the greater concern may be the incorrect installaion of some new devices. Installation errors occurred in all divisions inspected. To examine whether preliminary findings regarding degraded devices and installation errors were evident in other parts of the service area, We performed a cursory inspection of 30 additional poles in three other divisions: North Bay, North Coast, and North Valley. Although fewer data were gathered on these poles, we found trends similar to those in the original six divisions.

Table 12. The results of the pole inspections in these three additional divisions

Division	Total Poles Inspected	# Poles with Degraded Devices (Class A or Class B)	% Poles with Degraded Devices	# Poles with Incomplete or Improperly Installed Devices	% Poles with Incomplete or Improperly Installed Devices
No. Bay	10	6	60	7	70
No. Coast	10	1	10	8	80
No. Valley	10	4	40	5	50

The number of poles with degraded devices ranged from one to six poles in each division. As was the case in the original six divisions, improperly installed devices were found on more than 50 percent of all poles inspected within the three new divisions.

There appears to be a lack of understanding of the purpose and intent of these particular devices and the importance of proper installation techniques. While it is not certain that improper or incomplete installation practices or degrading devices are the reason for the upward trend in wildlife-caused outages in most PG&E divisions, it is likely they present an ongoing risk.

3.5.6 Summary

There appear to be 2 major conclusions based on this study:

Age and chemical composition are the leading factors affecting the degradation rates of wildlife protective devices observed.

Wildlife protective devices that were not installed according to manufacturer recommendations or PG&E Engineering Standards.

3.5.7 Relative Risk for Wildlife-Caused Outage

Degraded devices and improperly or incomplete installed devices may pose a risk for future wildlife-caused electrical outages. Many bird and animal species, especially squirrels, choose power poles to escape predators, perch, nest, roost, and hunt. In particular, all horizontal surfaces on poles, such as metal brackets, crossarms, and the tops of electrical equipment such as transformers, capacitors, reclosers, and sectionalizers provide a suitable refuge for birds and arboreal animals. The greatest reduction of risk occurs when all electrically energized equipment in proximity to these surfaces is fully insulated with properly installed devices or is physically separated.

Although PG&E has purchased and installed many wildlife protective devices over the years and many poles are well protected, problem poles still exist. While redesign alternatives are the preferred solution for minimizing wildlife-caused outages on high risk poles, retrofitting existing high-risk-equipment poles with wildlife-protective devices is relatively inexpensive and has proven effective when done correctly. Therefore, it is incumbent on PG&E to select the right materials and follow correct installation procedures. It is also necessary that the equipment, once installed, is designed and manufactured with quality materials that will withstand the normal climatic conditions experienced by electric utilities.

In its field investigations, we passed through many rural areas of central California and sections of the coast that are experiencing dramatic land use changes. Large tracts of land are being transformed from oak woodland and grassland into vineyards, orchards, dairies, feedlots, livestock ranches, housing tracts and landfill operations, resulting in the direct loss of trees and the addition of newly created habitat. These newly developed areas are known to attract various bird species such as starlings, blackbirds, and raptors, and squirrels, all of which are vulnerable to electrocutions and related outages. The removal of trees and shrubs and the installation of more electric services to these facilities will put more pressure on birds to perch and nest on nearby overhead electrical equipment. For instance, some farmers are installing wooden boxes to attract barn owls to nest in vineyards and orchards to control rodent populations (Moore et al. 1998). Owls rank fourth in species most associated with bird-caused outages within the PG&E service area (PG&E 1999, In Press).

3.6 Recommendations

3.6.1 Training

- Further training sessions should be developed and improved to provide field crews with information on the safety, importance, use, and proper installation of add-on devices to reduce wildlife-created outages. Hands-on instruction should be provided to update personnel, the many wildlife protective devices now available, appropriate installation practices, and safety. All field employees involved in the construction, maintenance and operation of distribution lines should be offered this training, which places greater emphasis on how or why a device works.
- Additional training should be developed for electric distribution planners and estimators to targethigh-risk poles for improvements during scheduled maintenance
- Improvements should be made to problem tracking of wildlife protection devices.
- Manufacturers should be encouraged to improve their wildlife protection product lines.
- Consideration should be given to creating a video showing the relevance, proper use and installation of all wildlife protective devices now offered in the *Raptor-Safe Construction and Wildlife Protection Distribution Pole Lines Standards*, recently issued (#061149, Oct 1, 1998). This program should emphasize the importance of system reliability and the relevance of the California Endangered Species Act, Federal Endangered Species Act, Federal Migratory Bird Treaty Act, and Federal Bald Eagle Protection Act to PG&E.

3.6.2 Installation Practices

- Equipment poles identified on circuits with a history of wildlife-caused outages should be targeted for the addition of bushing covers (or electrostatic guards) and insulated jumpers (or insulated jumper wire) during rebuilds and any scheduled maintenance. Equipment poles located in areas such as dairies, feedlots, vineyards, orchards, land fills and wetlands that are known to attract birds, should undergo modified construction design and / or the addition of bushing covers and insulation, as appropriate.
- In areas where birds congregate and that have a history of wildlife-caused outages, properly fitted wildlife protective covers and jumper insulation or insulated wire should be placed on all new equipment poles, particularly transformers, capacitors, reclosers, risers and sectionalizers before they leave the service yard. In Diablo Division, we observed new single phase transformer poles being delivered to the job site with bushing covers and insulated jumpers pre-installed, and the recommendation is that this practice be more widely adopted.

3.6.3 Device Selection

While we observed some signs of product degradation, this does not imply the need to remove or replace such wildlife protective devices at this time. Even devices that are improperly installed or show signs of degradation provide a degree of protection and help reduce the risk for a wildlife-caused outage. While most covers and insulated products do minimize the risk for an electrical outage and potential mortality, not all devices are suitable for all pole or bushing configurations. PG&E Engineering Standards #061149 provides clear guidance for selecting appropriate devices for particular bushings. Additional recommendations are as follows:

- Unless jumper wires are changed out, "Squirrely" wildlife covers should not be used on existing jumpers that are too short to support them. These covers should always be installed in a vertical orientation. Other styles of covers, shorter design, for example, should be used on bushings with short jumpers.
- Care should be exercised in installing Fargo covers. Since these covers come in various sizes, they should not be sized to fit the bushing. Currently, the most widely used cover in the electrical utility industry is manufactured by Fargo Corporation (PG&E 1999, In Press).
- Insulation wire covering should be purchased in rolls (not precut sections) to save cost and provide for "cut to fit" installation. Every effort should be made to cover jumpers completely, particularly those that pass directly over metal brackets or other horizontal surfaces where bushings are located.
- Electrostatic guards such as the Guthrie Guard should be considered for use on all problem poles with bushing-mounted cutouts instead of the Lineway Protective cover. TES tested the Lineway Protective cover (PG&E 1994), and determined that, among other problems, this cover failed to completely isolate the energized parts of the equipment and allowed wildlife to contact energized surfaces.
- Apparently, Eritech bushing covers are the only PVC-based covers currently installed within PG&E (Diablo Division). TES conducted laboratory tests on the effects of salt, fog, and ultraviolet light degradation on 12 different bushing covers during 1997 (PG&E 1999, In press). Eritech covers were ranked the lowest overall when compared to all other products tested. Based on these recent findings, this particular cover (made from PVC) was not coded and will no longer be installed within PG&E (Pers. comm. 1999, C. Poston).

3.6.4 Maintenance Practices

- Preparation of *Material Problem Reports* for all wildlife protective devices that fail in the field should continue to be encouraged. It is critical that protective devices that show early degradation in the field or manufacturing problems at the time of delivery be immediately reported, removed, replaced, and no longer purchased.
- Ideally, all electric-line maintenance trucks should be stocked with a variety of wildlife protective devices to enable line personnel to install these effective

devices on an as-needed basis. Although the trucks are often loaded with far more essential electrical hardware, at least a few such devices should be available for emergency or urgent installations.

- Poles modified with wildlife protective devices should be reinspected as a quality control measure after completion of the work.

3.6.5 Manufacturing Improvements

- Utilities should expect device manufacturers to continue to improve this product line. Further advances in material composition, design, and long-term aging are essential to the utilities' efforts to reduce wildlife-caused outages. Manufacturers should be encouraged to continue their efforts in product development and in the gathering of more utility field information.

4.0 References

4.1 Wildlife and Powerline Assessment Tool References

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Appendix I

TYPICAL COMPUTER SESSION USING THE ELECTRIC DISTRIBUTION MAP SERVER

Appendix II

PG&E – EVALUATING WILDLIFE PROTECTIVE DEVICES 1998-1999

(FIELD FORM)

APPENDIX III

RATIO OF 14 DIFFERENT WILDLIFE PROTECTIVE DEVICES TO OVERHEAD LINE MILES FOUND IN EACH DIVISION

Legend

BFD – Bird Flight Diverter, Regular & Large

Cond Spacers - Conductor Spacers (3 sizes)

Electrostatic Guard – Guthrie, Regular & Large

Fargo Cvr - Fargo Cover

Line Cvr – Lineway Cover

Molny Cvr – Moloney Cover

PVC Tube - PVC Jumper Insulation

Sal BWC – Salisbury Bare Wire Cover

Sal LWC – Salisbury Line Wire Cover

Squirrely Cover

APPENDIX IV

SELECTED PHOTOS OF DEGRADED WILDLIFE PROTECTIVE DEVICES

(Pole #1 SW)

(Pole #9 SW)

(Pole # 34 FW)

APPENDIX V

SELECTED PHOTOS OF IMPROPERLY INSTALLED WILDLIFE PROTECTIVE DEVICES

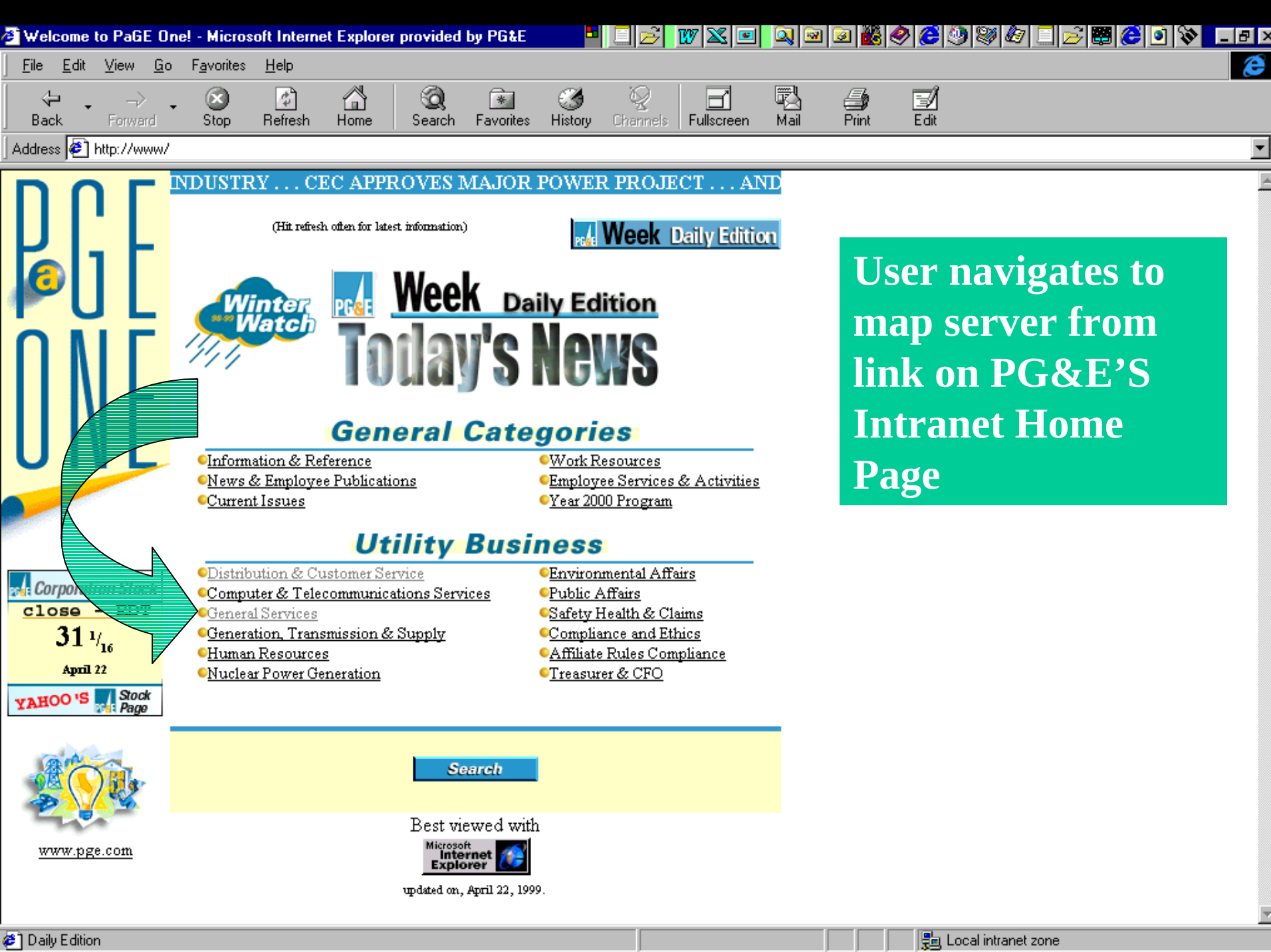
(Pole #7)

(Pole #10)

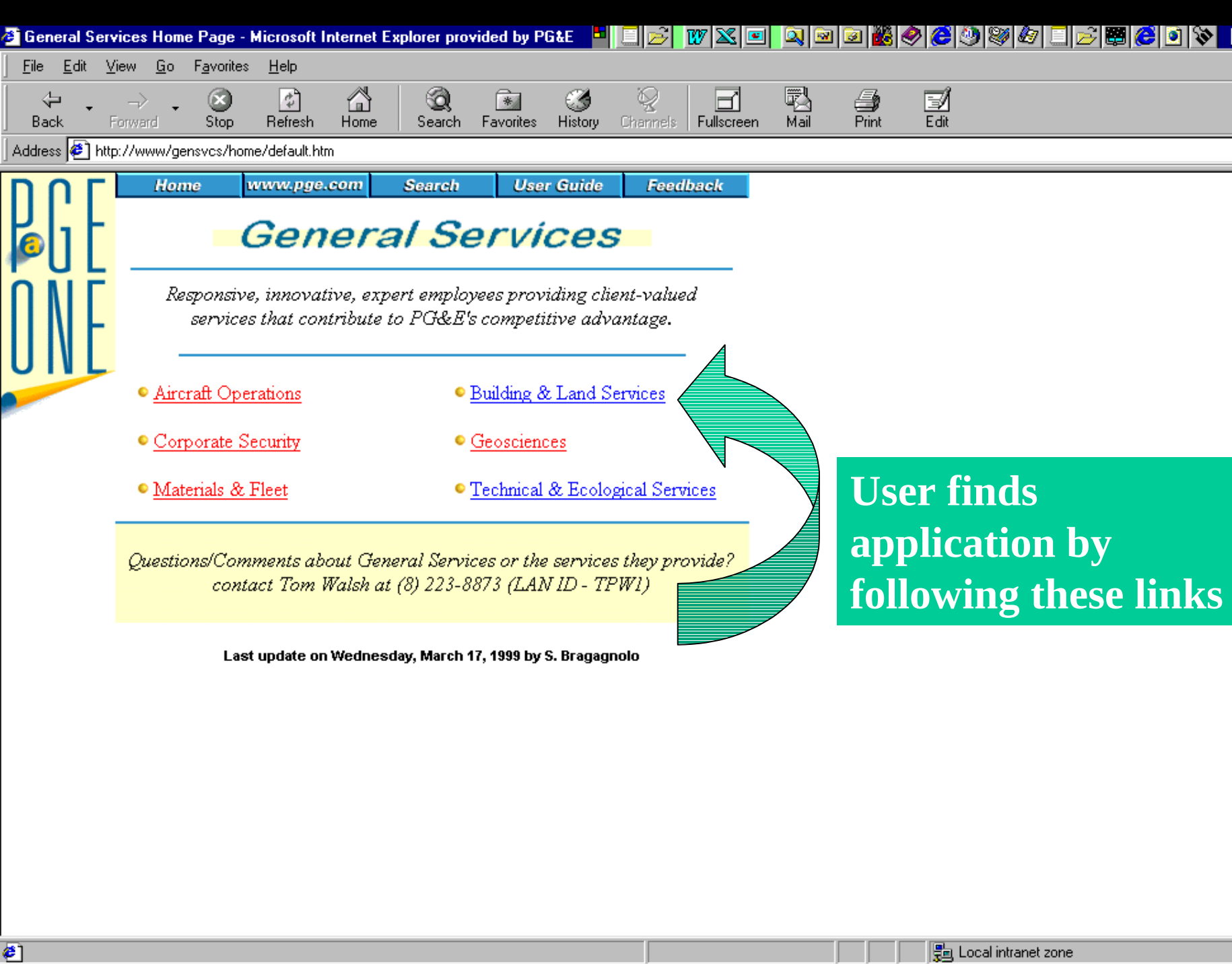
(Pole #37)

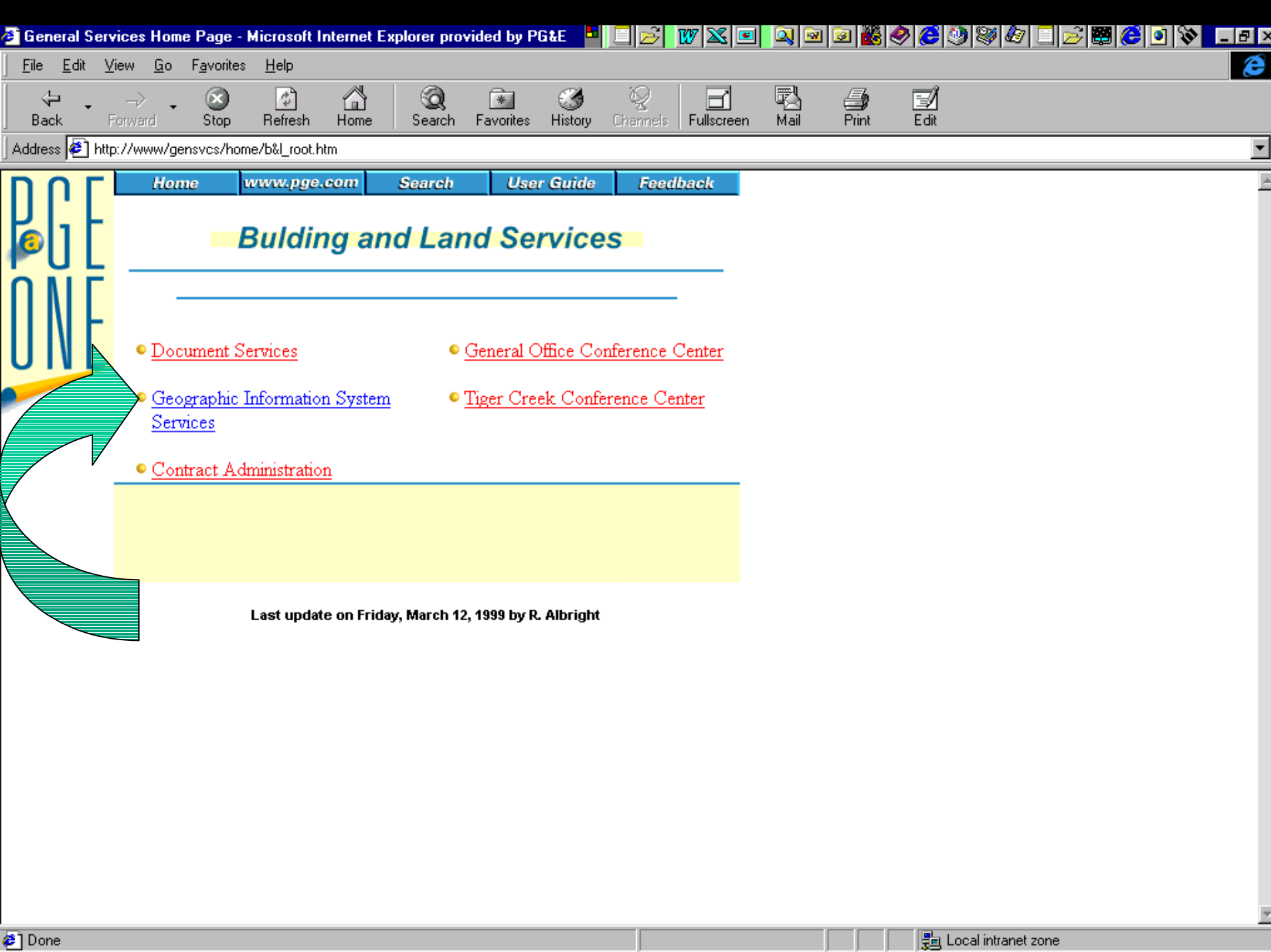
Appendix A

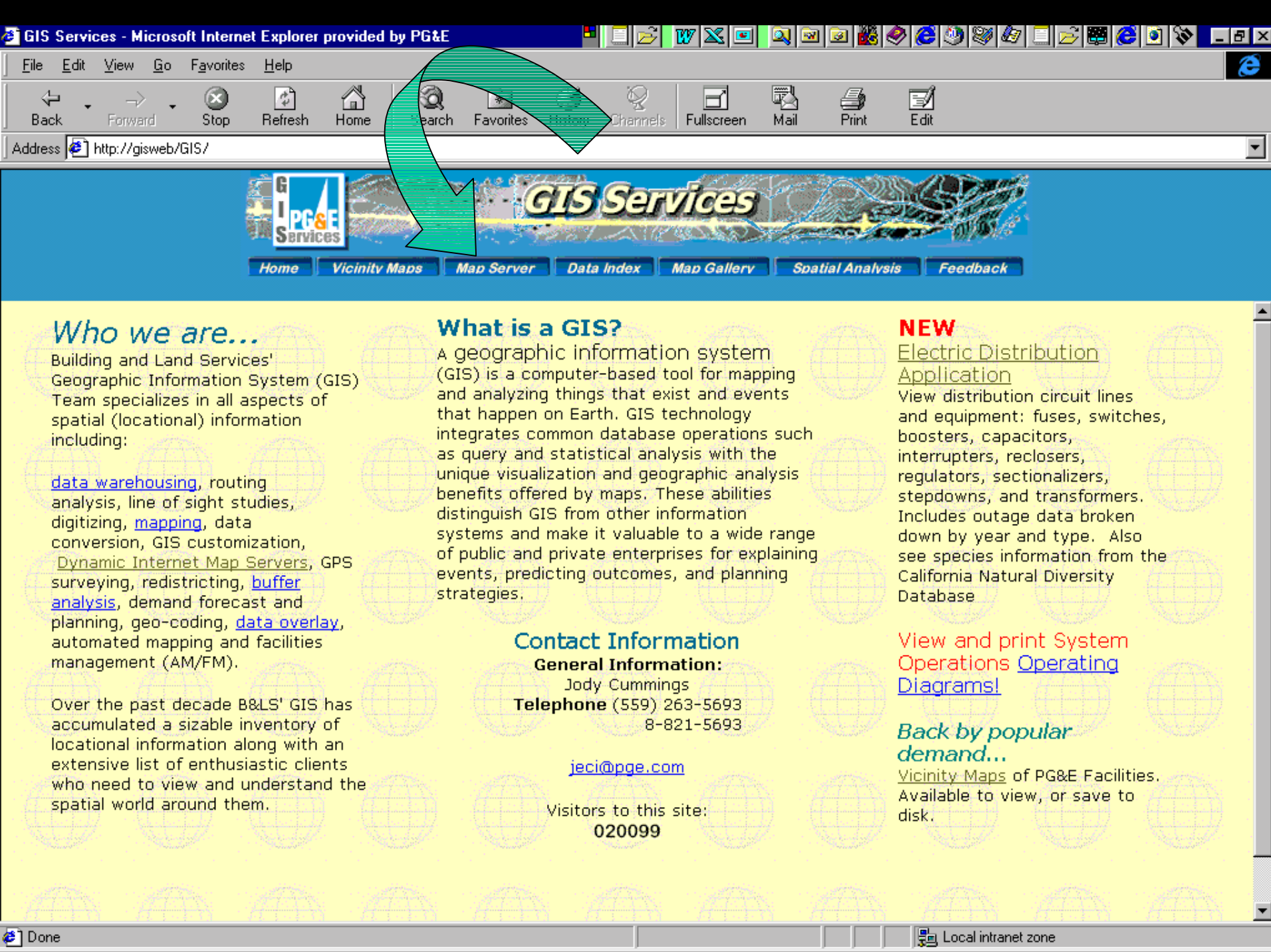
TYPICAL COMPUTER SESSION USING THE ELECTRIC DISTRIBUTION MAP SERVER



User navigates to map server from link on PG&E'S Intranet Home Page


General Services Home Page - Microsoft Internet Explorer provided by PG&E
File Edit View Go Favorites Help
Back Forward Stop Refresh Home Search Favorites History Channels Fullscreen Mail Print Edit
Address http://www/gensvcs/home/default.htm
Home www.pge.com Search User Guide Feedback
General Services
Responsive, innovative, expert employees providing client-valued services that contribute to PG&E's competitive advantage.
Aircraft Operations
Building & Land Services
Corporate Security
Geosciences
Materials & Fleet
Technical & Ecological Services
Questions/Comments about General Services or the services they provide? contact Tom Walsh at (8) 223-8873 (LAN ID - TPW1)
Last update on Wednesday, March 17, 1999 by S. Bragagnolo
User finds application by following these links
Local intranet zone


General Services Home Page - Microsoft Internet Explorer provided by PG&E
File Edit View Go Favorites Help
Back Forward Stop Refresh Home Search Favorites History Channels Fullscreen Mail Print Edit
Address http://www/gensvcs/home/b&l_root.htm
Home www.pge.com Search User Guide Feedback
Bulding and Land Services
Document Services
General Office Conference Center
Geographic Information System Services
Tiger Creek Conference Center
Contract Administration
Last update on Friday, March 12, 1999 by R. Albright
Done
Local intranet zone


GIS Services - Microsoft Internet Explorer provided by PG&E
File Edit View Go Favorites Help
Back Forward Stop Refresh Home Search Favorites Channels Fullscreen Mail Print Edit
Address http://gisweb/GIS/
GIS Services
Home
Vicinity Maps
Map Server
Data Index
Map Gallery
Spatial Analysis
Feedback
Who we are...
Building and Land Services' Geographic Information System (GIS) Team specializes in all aspects of spatial (locational) information including:
data warehousing, routing analysis, line of sight studies, digitizing, mapping, data conversion, GIS customization, Dynamic Internet Map Servers, GPS surveying, redistricting, buffer analysis, demand forecast and planning, geo-coding, data overlay, automated mapping and facilities management (AM/FM).
Over the past decade B&LS' GIS has accumulated a sizable inventory of locational information along with an extensive list of enthusiastic clients who need to view and understand the spatial world around them.
What is a GIS?
A geographic information system (GIS) is a computer-based tool for mapping and analyzing things that exist and events that happen on Earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies.
Contact Information
General Information:
Jody Cummings
Telephone (559) 263-5693
8-821-5693
jeci@pge.com
Visitors to this site:
020099
NEW
Electric Distribution Application
View distribution circuit lines and equipment: fuses, switches, boosters, capacitors, interrupters, reclosers, regulators, sectionalizers, stepdowns, and transformers. Includes outage data broken down by year and type. Also see species information from the California Natural Diversity Database
View and print System Operations Operating Diagrams!
Back by popular demand...
Vicinity Maps of PG&E Facilities. Available to view, or save to disk.
Done
Local intranet zone

Please Note!

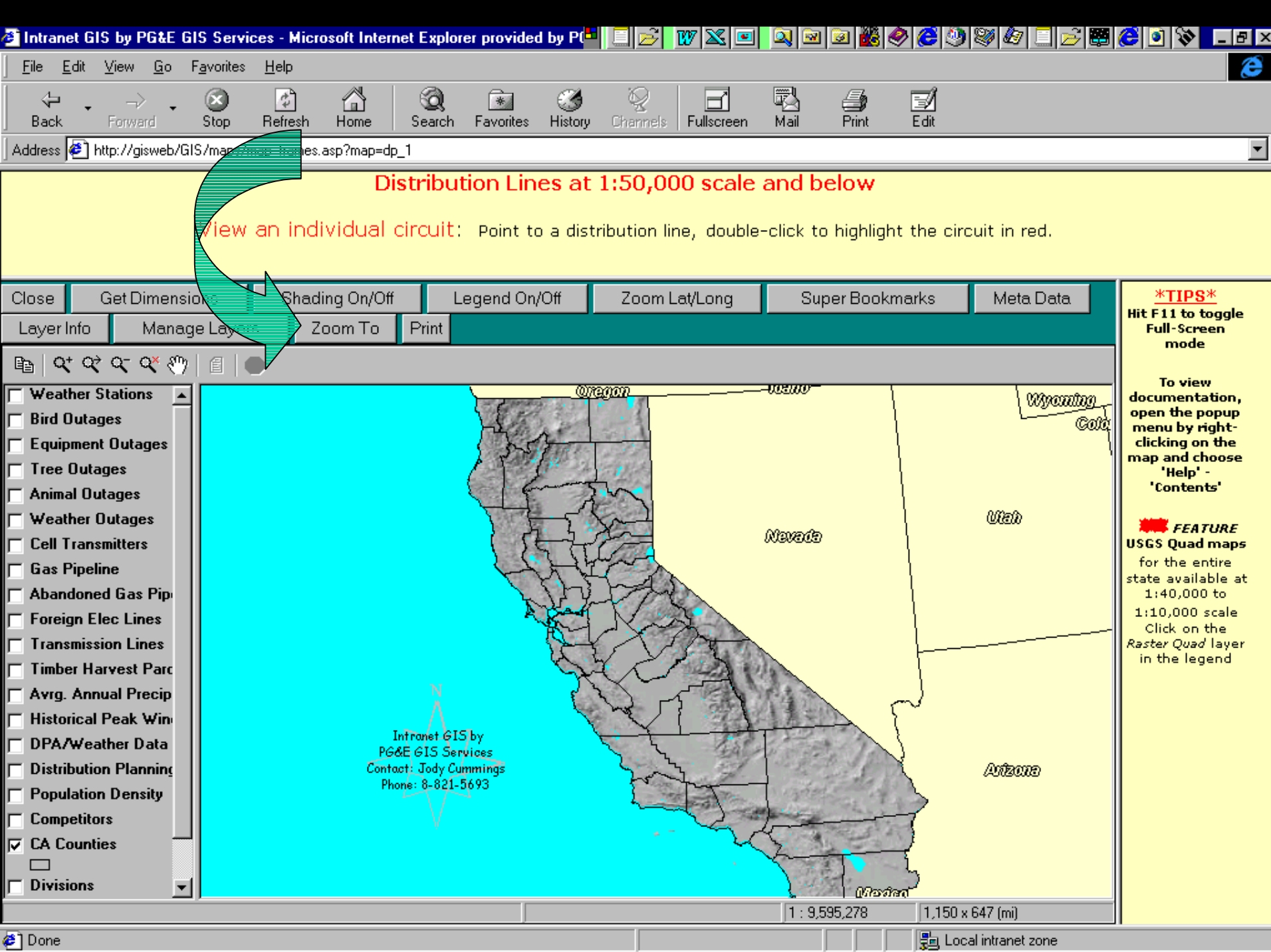
These applications will install or update the required ActiveX Controls
(this takes about 1 to 5 minutes)
REQUIREMENTS: Windows 95 or NT, and Internet Explorer 4.0 or higher

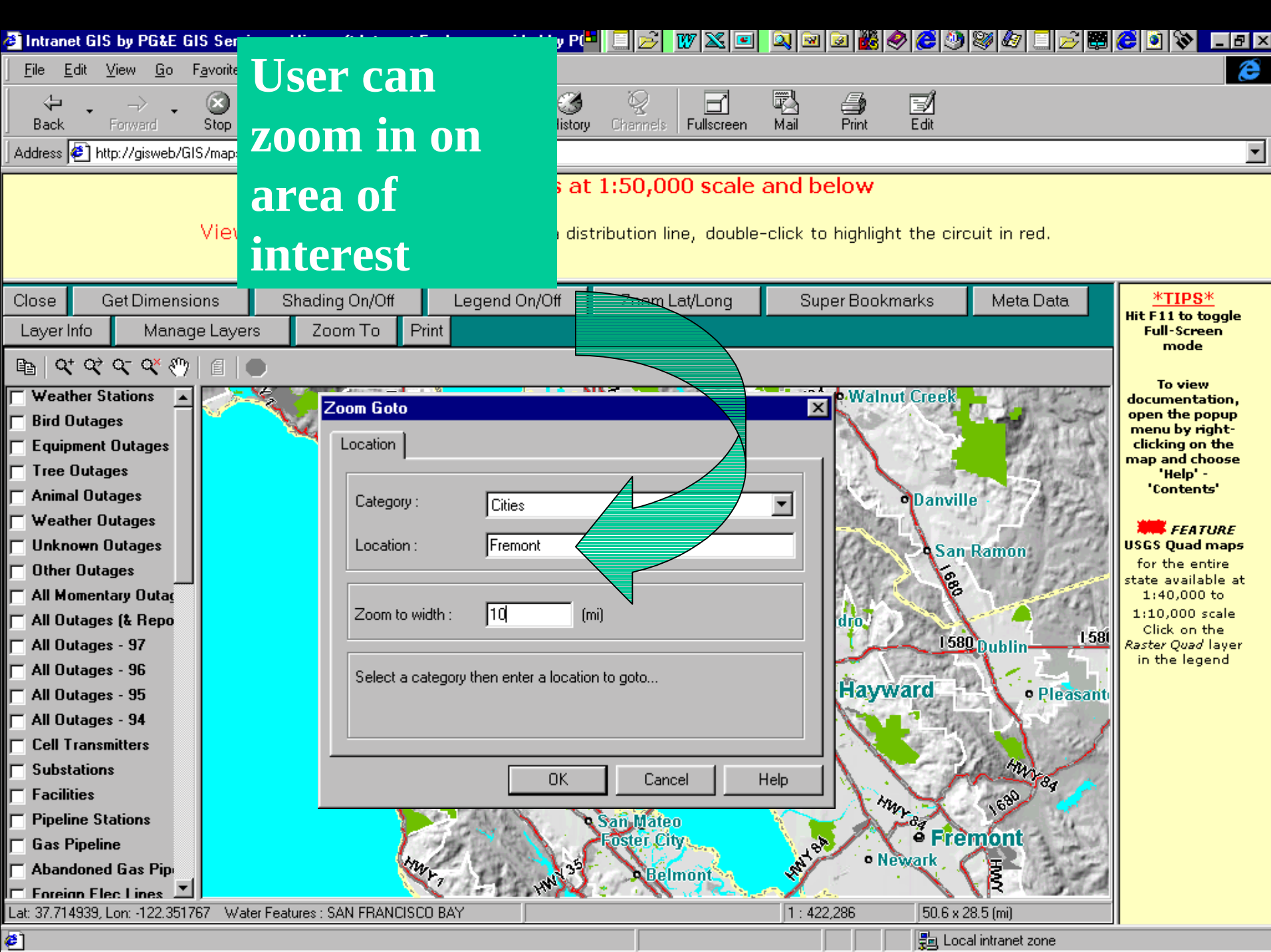
If you require assistance please call Jody Cummings at 8-821-5693

Intranet GIS Applications

DCS Engineering & Planning Distribution lines, EDSA data, species information from the California Natural Diversity Database (CNDDB)	**Geosciences** A joint project between GIS Services, Geosciences, C&TS and the U.S. Geological Survey, this application displays earthquakes categorized by magnitude and time of occurrence (last hour, last day, last week) in relation to PG&E facilities.
Rates and Account Services ***Now see all Non-Residential Customers!*** (at scales up to 1/50,000) Customer locations with account information. Competitors: boundaries and transmission lines. Requires user authorization. Contact Donn McPhail. DAMq@pge.com	**Hydro Generation** FERC Project boundaries and Hydro assets. *Water Rights Links* (Requires Internet Access) PG&E Facility Links to WRIMS Data Query Water Right Information View Water Right Licenses CA Water Code (Law) CA Water Rights GIS Demo
Electric Transmission Maintenance	**Technology Service Center**
California Gas Transmission Contains layers for pipelines (pipe specs), stations, and main line valves.	**Building and Land Inventory (BLI)** View PG&E land assets linked directly to the Building and Land Inventory SQL Server

23599


Intranet GIS by PG&E GIS Services - Microsoft Internet Explorer provided by PG
File Edit View Go Favorites Help
Back Forward Stop Refresh Home Search Favorites History Channels Fullscreen Mail Print Edit
Address http://gisweb/GIS/map
es.asp?map=dp_1
Distribution Lines at 1:50,000 scale and below
View an individual circuit: Point to a distribution line, double-click to highlight the circuit in red.
Close
Get Dimensio
Shading On/Off
Legend On/Off
Zoom Lat/Long
Super Bookmarks
Meta Data
Layer Info
Manage Lay
Zoom To
Print
Weather Stations
Bird Outages
Equipment Outages
Tree Outages
Animal Outages
Weather Outages
Cell Transmitters
Gas Pipeline
Abandoned Gas Pip
Foreign Elec Lines
Transmission Lines
Timber Harvest Parc
Avrg. Annual Precip
Historical Peak Win
DPA/Weather Data
Distribution Planning
Population Density
Competitors
CA Counties
Divisions
Oregon
Wyoming
Nevada
Utah
Arizona
Intranet GIS by
PG&E GIS Services
Contact: Jody Cummings
Phone: 8-821-5693
1 : 9,595,278
1,150 x 647 (mi)
TIPS
Hit F11 to toggle Full-Screen mode
To view documentation, open the popup menu by right-clicking on the map and choose 'Help' - 'Contents'
FEATURE
USGS Quad maps
for the entire state available at 1:40,000 to 1:10,000 scale
Click on the Raster Quad layer in the legend
Done
Local intranet zone


User can zoom in on area of interest
Intranet GIS by PG&E GIS Ser
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Address http://gisweb/GIS/maps
at 1:50,000 scale and below
distribution line, double-click to highlight the circuit in red.
Close Get Dimensions Shading On/Off Legend On/Off Super Bookmarks Meta Data
Layer Info Manage Layers Zoom To Print
Weather Stations
Bird Outages
Equipment Outages
Tree Outages
Animal Outages
Weather Outages
Unknown Outages
Other Outages
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All Outages - 95
All Outages - 94
Cell Transmitters
Substations
Facilities
Pipeline Stations
Gas Pipeline
Abandoned Gas Pip
Foreign Elec Lines
Zoom Goto
Location
Category : Cities
Location : Fremont
Zoom to width : 10 (mi)
Select a category then enter a location to goto...
OK Cancel Help
Walnut Creek
Danville
San Ramon
I 680
I 580
Dublin
Hayward
Pleasant
HWY 84
San Mateo
Foster City
Belmont
Newark
Fremont
HWY 1
HWY 35
TIPS
Hit F11 to toggle Full-Screen mode
To view documentation, open the popup menu by right-clicking on the map and choose 'Help' - 'Contents'
FEATURE
USGS Quad maps
for the entire state available at 1:40,000 to 1:10,000 scale
Click on the Raster Quad layer in the legend
Lat: 37.714939, Lon: -122.351767 Water Features : SAN FRANCISCO BAY
1 : 422,286
50.6 x 28.5 (mi)
Local intranet zone

Intranet GIS by PG&E GIS Services - Microsoft Internet Explorer provided by P

File Edit View Go Favorites Help

Back Forward Stop Refresh Home Search Favorites History Channels Fullscreen Mail Print Edit

Address http:/ /maps/map_frames.asp?map=dp_1

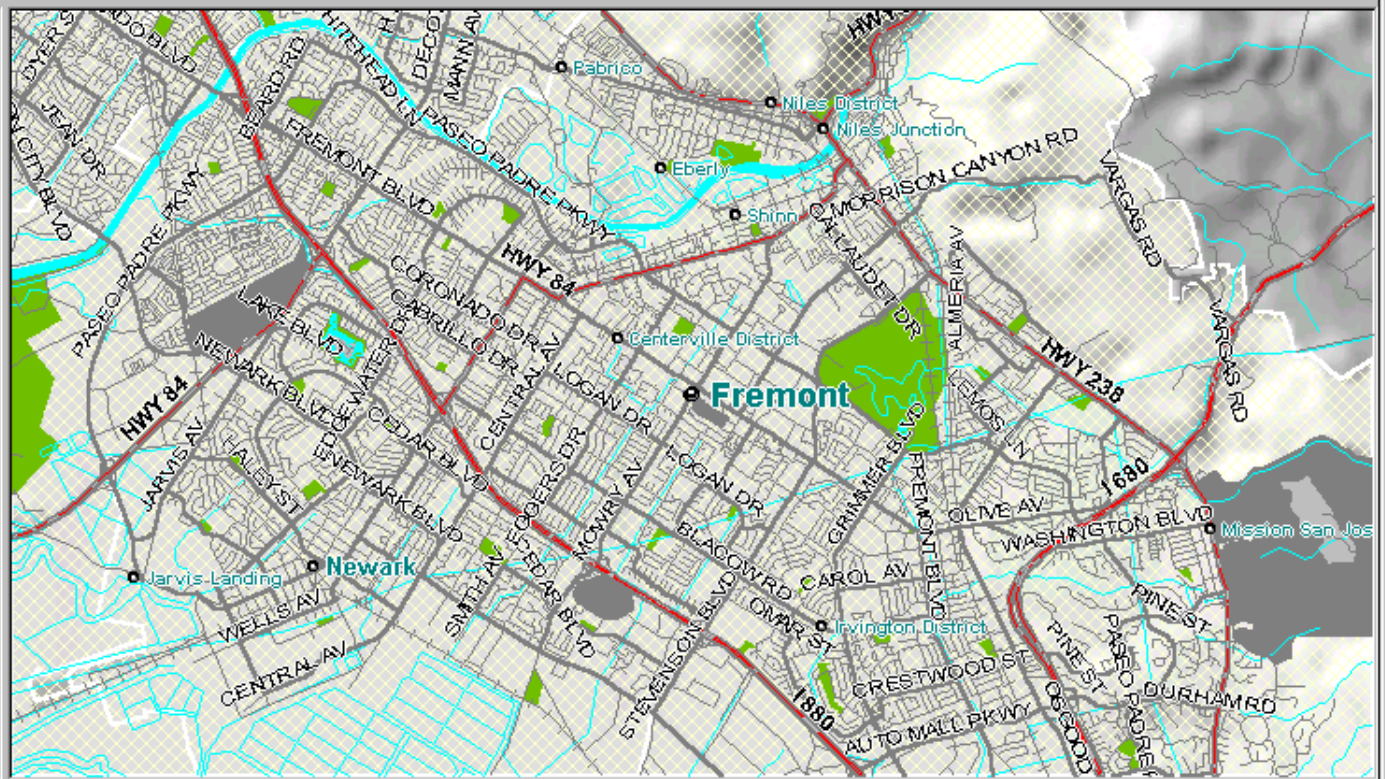
Distribution Lines at 1:50,000 scale and below

View an individual circuit: Point to a distribution line, double-click to highlight the circuit in red.

Clo Get Dimensions | Shading On/Off | Legend On/Off | Zoom Lat/Long | Super Bookmarks | Meta Data

La Manage Layers | Zoom To | Print

- Weather Stations
- Bird Outages
- Equipment Outages
- Tree Outages
- Animal Outages
- Weather Outages
- Unknown Outages
- Other Outages
- All Momentary Outag
- All Outages (& Repo
- All Outages - 97
- All Outages - 96
- All Outages - 95
- All Outages - 94
- Fuses
- Switches
- Boosters
- Autoboosters
- Capacitors
- Reclosers
- Sectionalizers



Lat: 37.539727, Lon: -121.973417 Major Roads : STEVENSON BLVD | 1 : 83,437 | 10.0 x 5.62 (mi)

TIPS

Hit F11 to toggle Full-Screen mode

To view documentation, open the popup menu by right-clicking on the map and choose 'Help' - 'Contents'

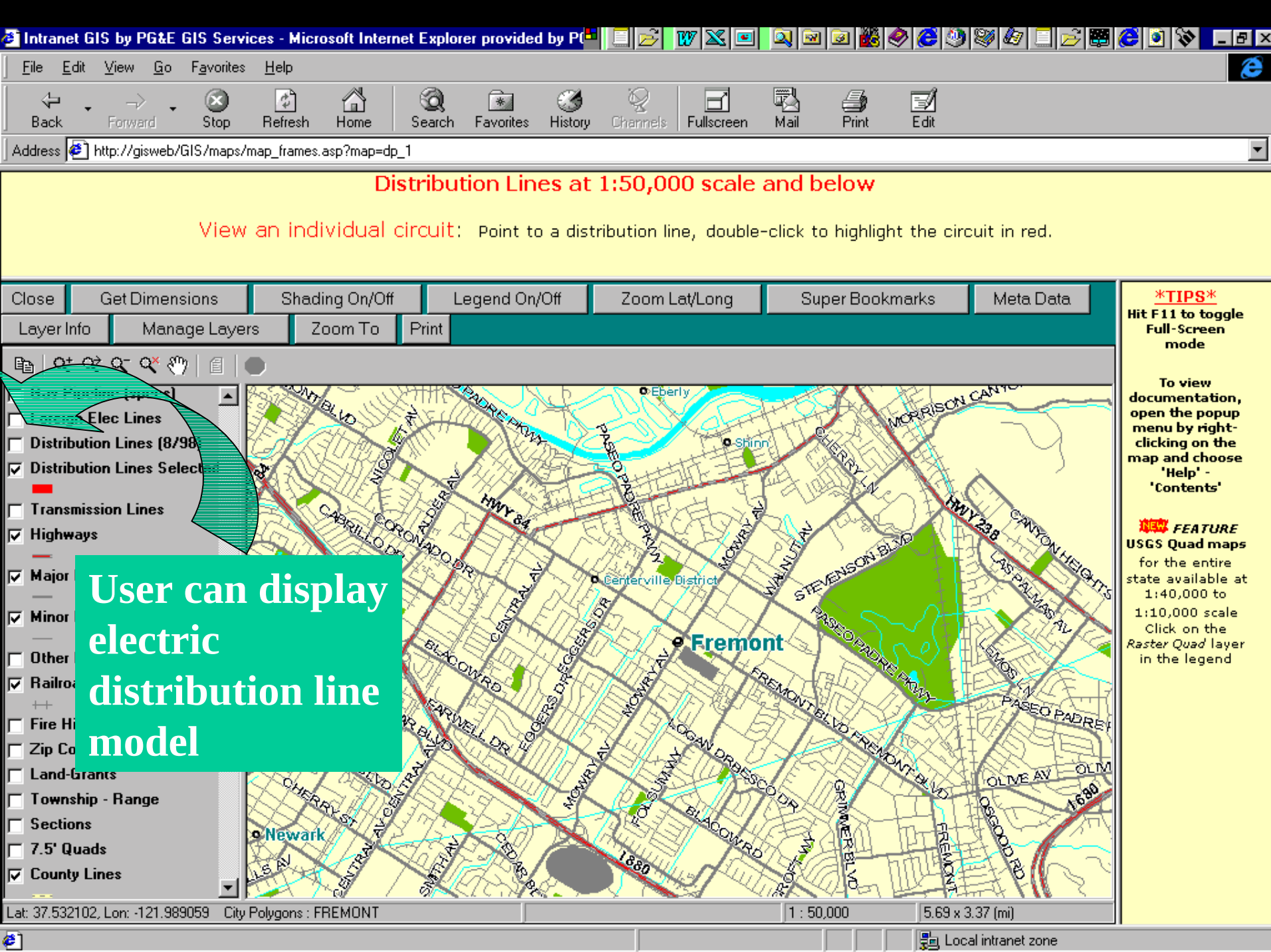
NEW *FEATURE*

USGS Quad maps

for the entire state available at 1:40,000 to 1:10,000 scale

Click on the *Raster Quad* layer in the legend

Local intranet zone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Address http://gisweb/GIS/maps/map_frames.asp?map=dp_1
Distribution Lines at 1:50,000 scale and below
View an individual circuit: Point to a distribution line, double-click to highlight the circuit in red.
Close
Get Dimensions
Shading On/Off
Legend On/Off
Zoom Lat/Long
Super Bookmarks
Meta Data
Layer Info
Manage Layers
Zoom To
Print
Elec Lines
Distribution Lines (8/98
Distribution Lines Select
Transmission Lines
Highways
Major
Minor
Other
Railroa
Fire Hi
Zip Co
Land-Grants
Township - Range
Sections
7.5' Quads
County Lines
User can display electric distribution line model
Eberly
Shinn
Centerville District
Fremont
Newark
HWY 84
HWY 238
1680
PASEO PADRE PKWY
FREMONT BLVD
MOWRY AV
CHERRY LN
STEVENSON BLVD
CENTRAL AV
BLACOW RD
LOGAN DR
OLME AV
TIPS
Hit F11 to toggle Full-Screen mode
To view documentation, open the popup menu by right-clicking on the map and choose 'Help' - 'Contents'
NEW FEATURE
USGS Quad maps
for the entire state available at 1:40,000 to 1:10,000 scale
Click on the Raster Quad layer in the legend
Lat: 37.532102, Lon: -121.989059 City Polygons : FREMONT
1 : 50,000
5.69 x 3.37 (mi)
Local intranet zone

Intranet GIS by PG&E GIS Services - Microsoft Internet Explorer provided by P

File Edit View Go Favorites Help

Back Forward Stop Refresh Home Search Favorites History Channels Fullscreen Mail Print Edit

Address http://gisweb/GIS/maps/map_frames.asp?map=dp_1

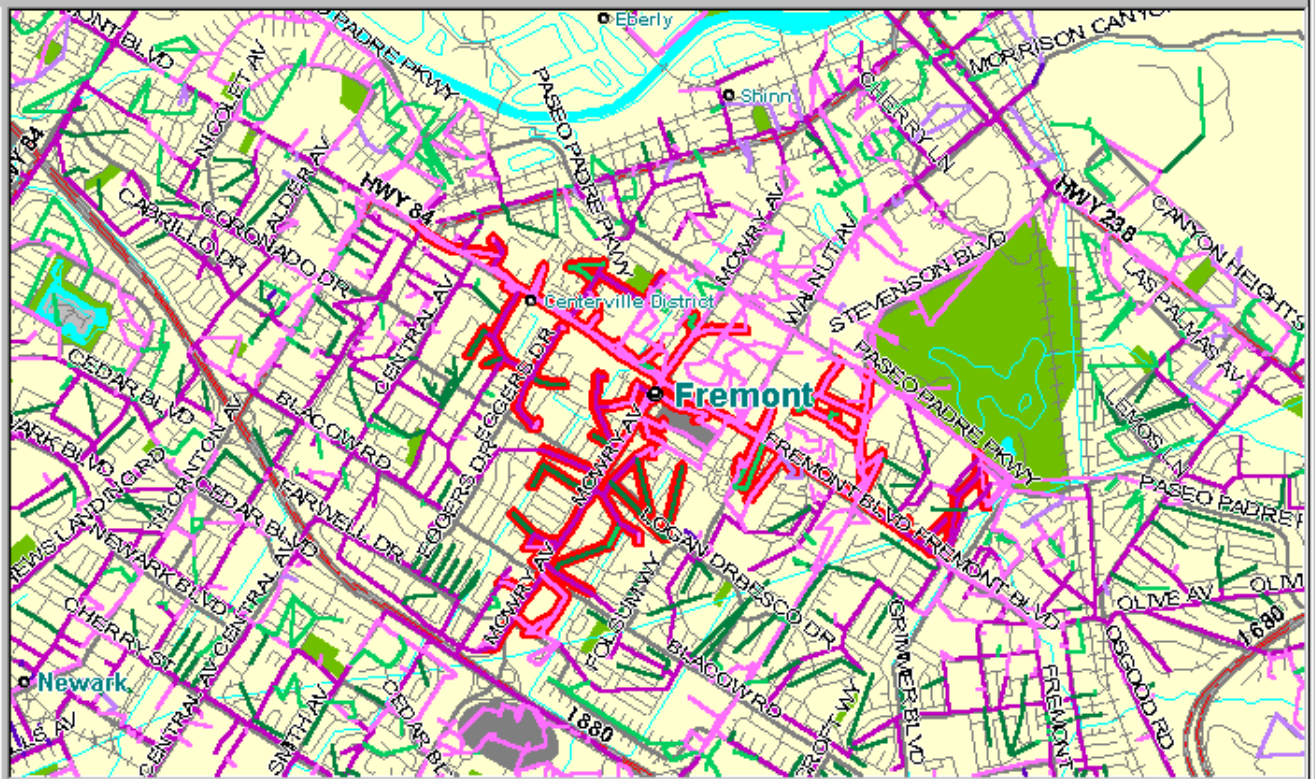
SELECTED DISTRIBUTION LINE DETAILS

CIRCUIT NAME: FREMONT 1107, CIRCUIT #: 014351107, VALUE: 11 KV

Close | Get Dimensions | Shading On/Off | Legend On/Off | Zoom Lat/Long | Super Bookmarks | Meta Data

Layer Info | Manage Layers | Zoom To | Print

- Gas Pipeline (specs)
- Foreign Elec Lines
- Distribution Lines (8/98)
  - Unknown
  - Overhead, 1 phase
  - Underground, 1 phase
  - Overhead, 2 phase
  - Underground, 2 phase
  - Overhead, 3 phase
  - Underground, 3 phase
- Distribution Lines Selected
- Transmission Lines
- Highways
- Major Roads
- Minor Roads
- Other Roads (Forest Srvc.
- Railroads
- Fire History
- Zip Codes
- Land-Grants



Lat: 37.551505, Lon: -121.993596 Distribution Lines (8/98) : Feeder #: 014351107-F | 1 : 50,000 | 5.69 x 3.37 (mi)

TIPS

Hit F11 to toggle Full-Screen mode

To view documentation, open the popup menu by right-clicking on the map and choose 'Help' - 'Contents'

NEW ***FEATURE***

USGS Quad maps for the entire state available at 1:40,000 to 1:10,000 scale

Click on the *Raster Quad* layer in the legend

javascript:toplink("show_dist.asp?FEEDER_NO=014351107")

Local intranet zone

Intranet GIS by PG&E GIS Services - Microsoft Internet Explorer provided by PG

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Address http://gisweb/GIS/maps/map_frames.asp?map=dp_1

OUTAGE REPORT

EQ OPER NO	EQUIP DESCRIPTION	OCCURANCE TIME	DESCRIPTION	SUPL DESCRIPTION	MAX CUSTS	CUST MIN	ID
7991	NONE	12/19/96 8:39:00 AM	foreign object or activity	bird	14	854	20534
7991	NONE	1/2/97 10:17:00 AM	foreign object or activity	bird	14	742	20534

Close | Get Dimensions | Shading On/Off | Legend On/Off | Zoom Lat/Long | Super Bookmarks | Meta Data

Layer Info | Manage Layers | Zoom To | Print

- Weather Stations
- Bird Outages
  - 1994 - 6/98
  - 1 event
  - 2 - 5 events
  - 6 - 10 events
  - > 10 events
- Equipment Outages
- Tree Outages
- Animal Outages
- Weather Outages
- Unknown Outages
- Other Outages
- All Momentary Outag
- All Outages (& Repo
- All Outages - 97
- All Outages - 96
- All Outages - 95
- All Outages - 94
- Fuses
- Switches

Bird-caused outages can be displayed and details reported

TIPS

Hit F11 to toggle Full-Screen mode

To view documentation, open the popup menu by right-clicking on the map and choose 'Help' - 'Contents'

FEATURE
S Quad maps
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er Quad layer
the legend

Lat: 37.559203, Lon: -122.008515 Bird Outages : Bird Outage Summary-12/19/96 to | 1 : 33,375 | 4.00 x 2.06 (mi)

Local intranet zone

Intranet GIS by PG&E GIS Services - Microsoft Internet Explorer provided by PG

File Edit View Go Favorites Help

Back Forward Stop Refresh Home Search Favorites History Channels Fullscreen Mail Print Edit

Address http://gisweb/GIS/maps/map_frames.asp?map=dp_1

OUTAGE REPORT

EQ OPER NO	EQUIP DESCRIPTION	OCCURANCE TIME	DESCRIPTION	SUPL DESCRIPTION	MAX CUSTS	CUST MIN	ID
7991	NONE	12/19/96 8:39:00 AM	foreign object or activity	bird	14	854	20534
7991	NONE	1/2/97 10:17:00 AM	foreign object or activity	bird	14	742	20534

Close | Get Dimensions | Shading On/Off | Legend On/Off | Zoom Lat/Long | Super Bookmarks | Meta Data

Layer Info | Manage Layers | Zoom To | Print

- Avrg. Annual Precip
- Silicon Valley Load
- Silicon Valley L
- Lightning Strike
- Historical Peak Wi
- Water Features
- DPA/Weather Data
- Distribution Planning
- Population Density
- Competitors
- Raster Quad
- Cultural Features
- City Polygons
- CA Counties
- Hillshade

Raster quad maps are available for entire service area

TIPS

Hit F11 to toggle Full-Screen mode

To view documentation, open the popup menu by right-clicking on the map and choose 'Help' - 'Contents'

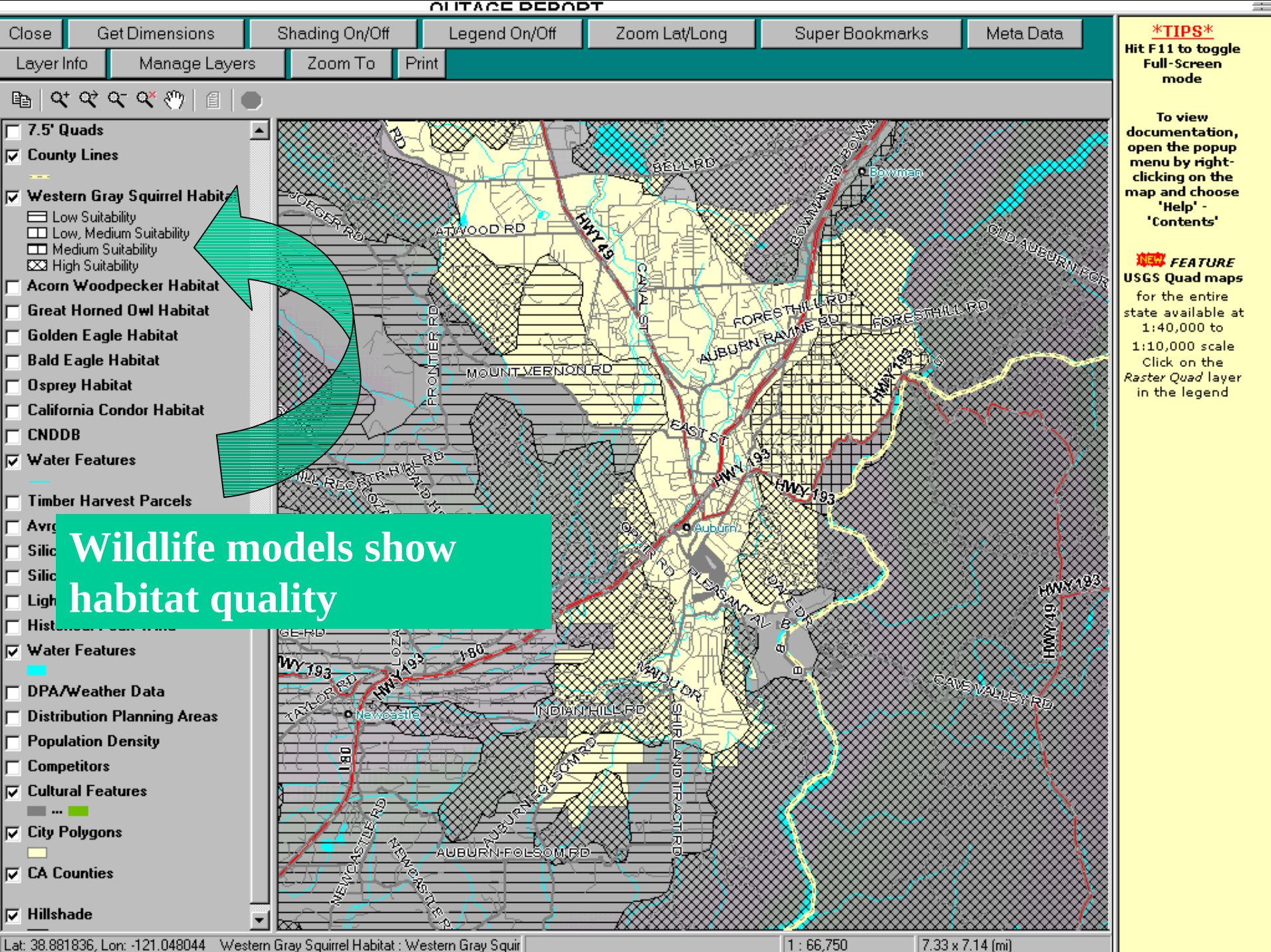
NEW ***FEATURE***

USGS Quad maps for the entire state available at 1:40,000 to 1:10,000 scale

Click on the *Raster Quad* layer in the legend

Done

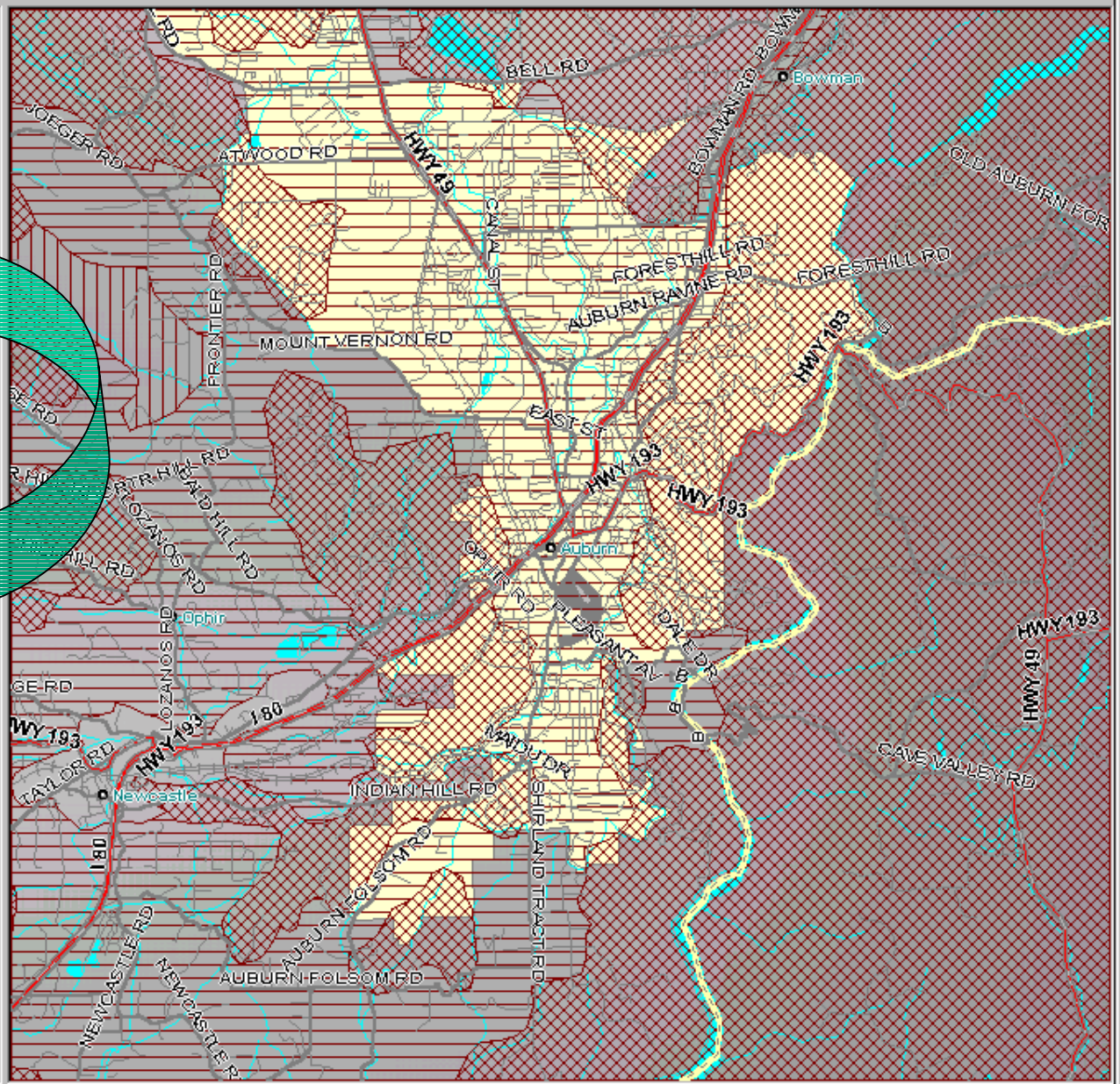
Local intranet zone


OUTAGE REPORT
Close
Get Dimensions
Shading On/Off
Legend On/Off
Zoom Lat/Long
Super Bookmarks
Meta Data
Layer Info
Manage Layers
Zoom To
Print
7.5' Quads
County Lines
Western Gray Squirrel Habitat
Low Suitability
Low, Medium Suitability
Medium Suitability
High Suitability
Acorn Woodpecker Habitat
Great Horned Owl Habitat
Golden Eagle Habitat
Bald Eagle Habitat
Osprey Habitat
California Condor Habitat
CNDDB
Water Features
Timber Harvest Parcels
Water Features
DPA/Weather Data
Distribution Planning Areas
Population Density
Competitors
Cultural Features
City Polygons
CA Counties
Hillshade
Wildlife models show habitat quality
TIPS
Hit F11 to toggle Full-Screen mode
To view documentation, open the popup menu by right-clicking on the map and choose 'Help' - 'Contents'
NEW FEATURE
USGS Quad maps
for the entire state available at 1:40,000 to 1:10,000 scale
Click on the Raster Quad layer in the legend
Auburn
Bowman
Newcastle
HWY 49
HWY 193
HWY 80
MOUNT VERNON RD
AUBURN RAVINE RD
FORESTHILL RD
EAST ST
CANAL ST
BOWMAN RD
BELL RD
ATWOOD RD
FRONTIER RD
INDIAN HILL RD
AUBURN-FOLSOM RD
NEWCASTLE RD
SHIRLAND TRACT RD
CAVE VALLEY RD
Lat: 38.881836, Lon: -121.048044
Western Gray Squirrel Habitat : Western Gray Squir
1 : 66,750
7.33 x 7.14 (mi)

Close | Get Dimensions | Shading On/Off | Legend On/Off | Zoom Lat/Long | Super Bookmarks | Meta Data

Layer Info | Manage Layers | Zoom To | Print

- [ ] Township - Range
- [ ] Sections
- [ ] 7.5' Quads
- [x] County Lines
- [ ] Western Gray Squirrel Habitat
- [ ] Acorn Woodpecker Habitat
- [ ] Great Horned Owl Habitat
- [x] Golden Eagle Habitat
  - Low Suitability
  - Low, Medium Suitability
  - High Suitability
- [ ] Bald Eagle Habitat
- [ ] Osprey Habitat
- [ ] California Condor Habitat
- [ ] CNDDB
- [x] Water Features
- [ ] Timber Harvest Parcels
- [ ] Avrg. Annual Precip
- [ ] Silicon Valley Load Change 97
- [ ] Silicon Valley Load Change 97
- [ ] Lightning Strike Density
- [ ] Historical Peak Wind
- [x] Water Features
- [ ] DPA/Weather Data
- [ ] Distribution Planning Areas
- [ ] Population Density
- [ ] Competitors
- [x] Cultural Features
- [x] City Polygons
- [x] CA Counties



TIPS

Hit F11 to toggle Full-Screen mode

To view documentation, open the popup menu by right-clicking on the map and choose 'Help' - 'Contents'

NEW *FEATURE*

USGS Quad maps for the entire state available at 1:40,000 to 1:10,000 scale

Click on the *Raster Quad* layer in the legend

Lat: 38.912095, Lon: -121.094948 | Golden Eagle Habitat : Golden Eagle-(Aquila Chrysa | 1 : 66,750 | 7.33 x 7.14 (mi)

Intranet GIS by PG&E GIS Services - Microsoft Internet Explorer provided by PG

File Edit View Go Favorites Help

Back Forward Stop Refresh Home Search Favorites History Channels Fullscreen Mail Print Edit

Address http://gisweb/GIS/maps/map_frames.asp?map=dp_1

CAUTION: ABSENCE OF SITE RECORDS DOES NOT MEAN SENSITIVE SPECIES ARE ABSENT AND DOES NOT REPLACE THE NEED FOR APPROPRIATE BIOLOGICAL REVIEW.

COMMON NAME	SCIENTIFIC NAME	FEDERAL DESC	CALIFORNIA DESC	LAST OBSERVED	OWNERSHIP
GIANT GARTER SNAKE	THAMNOPHIS GIGAS	Federally listed as Threatened	State listed as Threatened	19740506	UNKNOWN
GIANT GARTER SNAKE	THAMNOPHIS GIGAS	Federally listed as Threatened	State listed as Threatened	1976XXXX	UNKNOWN
CALIFORNIA BLACK RAIL	LATERALLUS JAMAICENSIS COTURNICULUS	Federal species of concern	State listed as Threatened	19820514	DWR

Close | Get Dimensions | Shading On/Off | Legend On/Off | Zoom Lat/Long | Super Bookmarks | Meta Data

Layer Info | Manage Layers | Zoom To | Print

- Bald Eagle Habitat
- Osprey Habitat
- California Condor Habitat
- CNDDB
  - 1
  - 2
  - 3
  - 4
  - 5 - 18
  - 18 - 21
- Water Features
- Timber Harvest Parcels
- Avrg. Annual Precip
- Lightning Strike Density
- Historical Peak Flow
- Water Features

Terminous Tomspur Black Lands Foppiano

Known occurrences of sensitive species can be displayed and details reported

View Report

CNDDB Report

OK Cancel

TIPS

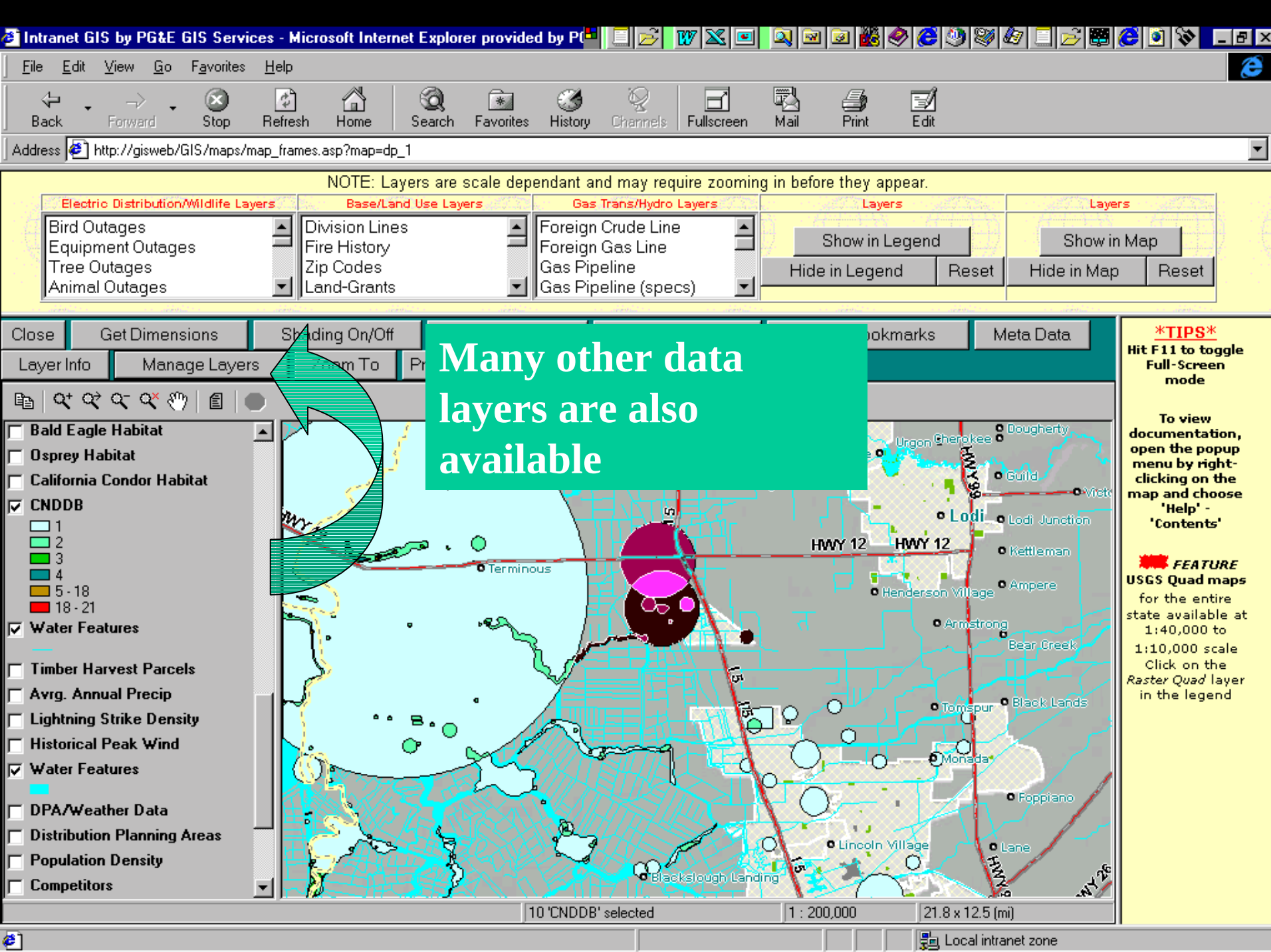
Hit F11 to toggle Full-Screen mode

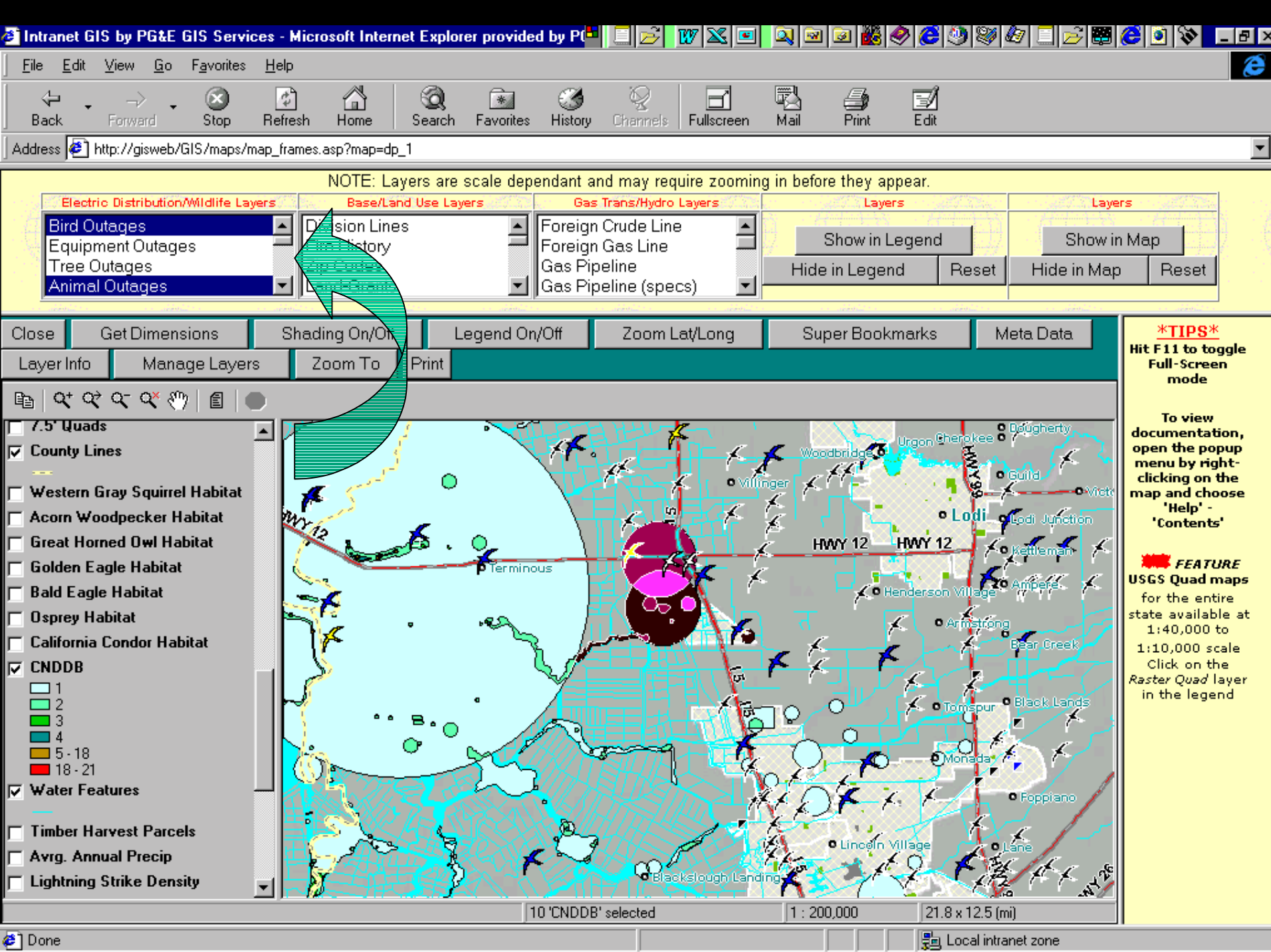
state available at 1:40,000 to 1:10,000 scale Click on the *Raster Quad* layer in the legend

Lat: 38.079293, Lon: -121.333772 Water Features :

Microsoft PowerPoint - [ma...

intranet zone


Intranet GIS by PG&E GIS Services - Microsoft Internet Explorer provided by PG
File Edit View Go Favorites Help
Back Forward Stop Refresh Home Search Favorites History Channels Fullscreen Mail Print Edit
Address http://gisweb/GIS/maps/map_frames.asp?map=dp_1
NOTE: Layers are scale dependant and may require zooming in before they appear.
Electric Distribution/Wildlife Layers
Bird Outages
Equipment Outages
Tree Outages
Animal Outages
Base/Land Use Layers
Division Lines
Fire History
Zip Codes
Land-Grants
Gas Trans/Hydro Layers
Foreign Crude Line
Foreign Gas Line
Gas Pipeline
Gas Pipeline (specs)
Layers
Show in Legend
Hide in Legend
Reset
Layers
Show in Map
Hide in Map
Reset
Close
Get Dimensions
Shading On/Off
Bookmarks
Meta Data
Layer Info
Manage Layers
Zoom To
Many other data layers are also available
Bald Eagle Habitat
Osprey Habitat
California Condor Habitat
CNDDB
1
2
3
4
5 - 18
18 - 21
Water Features
Timber Harvest Parcels
Avrg. Annual Precip
Lightning Strike Density
Historical Peak Wind
Water Features
DPA/Weather Data
Distribution Planning Areas
Population Density
Competitors
Terminous
HWY 12
Lodi
Lodi Junction
Kettleman
Ampere
Henderson Village
Armstrong
Bear Creek
Tomspur
Black Lands
Monada
Foppiano
Lincoln Village
Lane
Blackslough Landing
Dougherty
Guild
Urgon
Cherokee
TIPS
Hit F11 to toggle Full-Screen mode
To view documentation, open the popup menu by right-clicking on the map and choose 'Help' - 'Contents'
NEW FEATURE
USGS Quad maps for the entire state available at 1:40,000 to 1:10,000 scale
Click on the Raster Quad layer in the legend
10 'CNDDB' selected
1 : 200,000
21.8 x 12.5 (mi)
Local intranet zone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Zoom Lat/Long
Super Bookmarks
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Manage Layers
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Western Gray Squirrel Habitat
Acorn Woodpecker Habitat
Great Horned Owl Habitat
Golden Eagle Habitat
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Tomspur
Black Lands
Monada
Foppiano
Lincoln Village
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Click on the Raster Quad layer in the legend
Done
Local intranet zone

DP Index - Microsoft Internet Explorer provided by PG&E

Scale in thousands Example 2,000 is 1:2,000,000

Data Layer	15,000	2,000	1,000	500	250	200	150	100	75	50	35	10	0
Bird Outages													
Equipment Outages													
Tree Outages													
Animal Outages													
Weather Outages													
Unknown Outages													
Other Outages													
All Momentary Outages													
All Outages (& Report)													
All Outages - 97													
All Outages - 96													
All Outages - 95													
All Outages - 94													
Fuses													
Switches													
Boosters													
Autoboosters													
Capacitors													
Interrupters													
Reclosers													
Regulators													
Sectionalizers													
Stepdowns													
Transformers													
Substations													
Substation Labels													
Facilities													
Facility Labels													
Foreign Elec Lines													

Data layers are displayed at different scales

- Layer automatically shown in Legend at noted scales and checked on
- Layer automatically shown in Legend at noted scales and checked off

DP Index - Microsoft Internet Explorer provided by PG&E

Scale in thousands Example 2,000 is 1:2,000,000

Data Layer	15,000	2,000	1,000	500	250	200	150	100	75	50	35	10	0
Foreign Elec Lines													
Distribution Lines													
All Transmission Lines													
Highways													
Major Roads													
Minor Roads													
Other Roads (Forest Srvc.)													
Railroads													
Division Lines													
Fire History													
Zip Codes													
Land-Grants													
Township-Range													
Sections													
7.5' Quads													
County Lines													
Western Gray Squirrel Habitat													
Acorn Woodpecker Habitat													
Great Horned Owl Habitat													
Golden Eagle Habitat													
Osprey Habitat													
California Condor Habitat													
CNDDB (& Report)													
Water Features (lines)													
Silicon Valley Load Change													
Silicon Valley Load Change (Areas)													
Avrg. Annual Precipitation													
Lightning Strike Density													
Historical Peak Wind													

Available data layers (continued)

- Layer automatically shown in Legend at noted scales and checked on

- Layer automatically shown in Legend at noted scales and checked off

DP Index - Microsoft Internet Explorer provided by PG&E

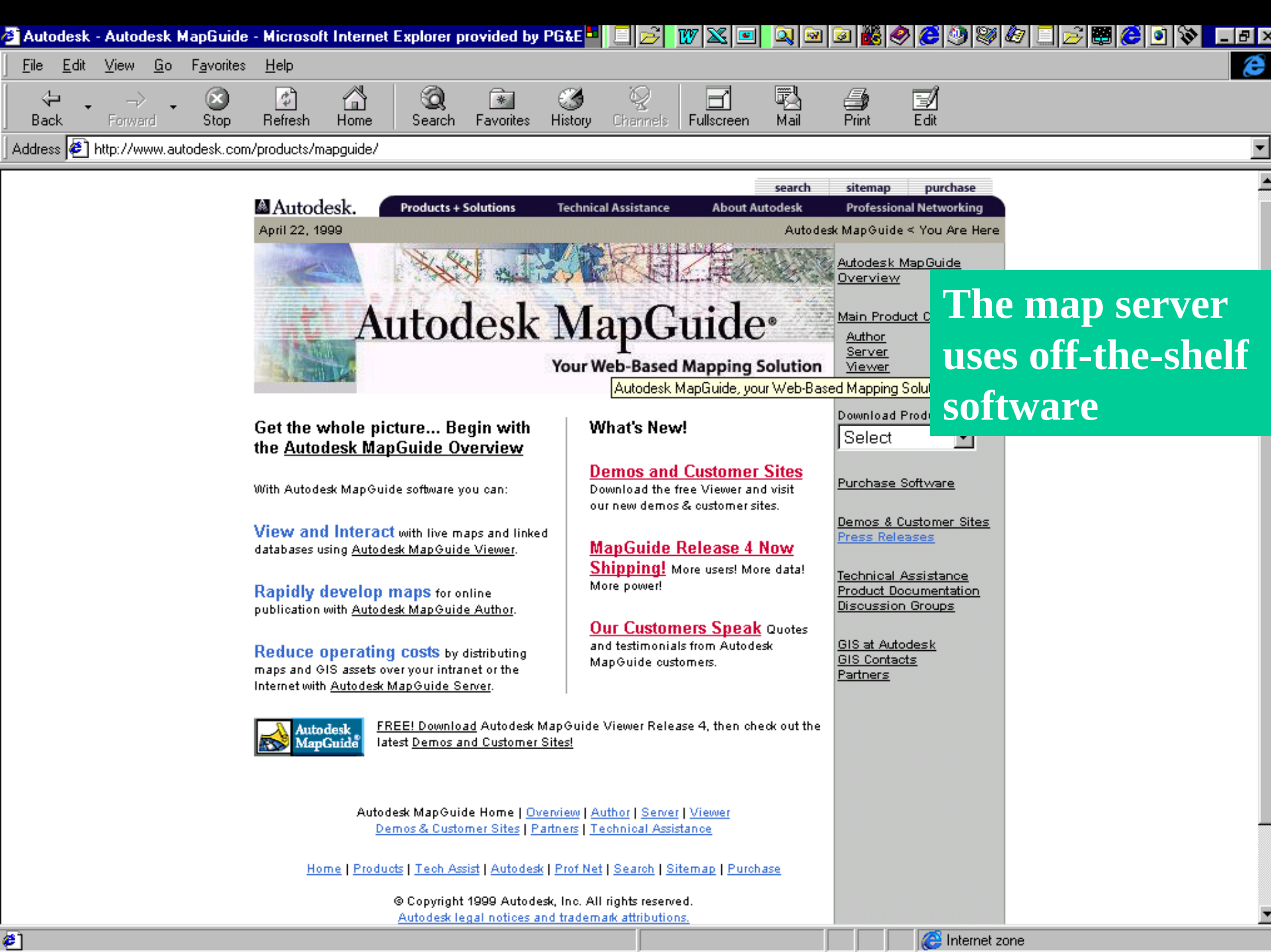
Scale in thousands Example 2,000 is 1:2,000,000

Data Layer	15,000	2,000	1,000	500	250	200	150	100	75	50	35	10	0
Township-Range													
Sections													
7.5' Quads													
County Lines													
Western Gray Squirrel Habitat													
Acorn Woodpecker Habitat													
Great Horned Owl Habitat													
Golden Eagle Habitat													
Osprey Habitat													
California Condor Habitat													
CNDDB (& Report)													
Water Features (lines)													
Silicon Valley Load Change													
Silicon Valley Load Change (Areas)													
Avrg. Annual Precipitation													
Lightning Strike Density													
Historical Peak Wind													
Water Features (Polygons)													
Daily Temp Data													
Distribution Planning Areas													
Population Density													
Military Lands													
Competitors													
Raster Quad													
Cultural Features													
City Polygons													
CA Counties													
Divisions													
Hillshade													

Available data layers (continued)

- Layer automatically shown in Legend at noted scales and checked on

- Layer automatically shown in Legend at noted scales and checked off



The map server uses off-the-shelf software

Autodesk MapGuide Home

Autodesk MapGuide Overview

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Product Documentation
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Our Customers Speak

"At Sprint, people need to use sophisticated GIS tools without knowing GIS. Autodesk MapGuide makes this possible. With it, we can create maps on the fly. We can quickly click on map points to access associated information. And we can analyze data and create reports that can be shared throughout our network. It's a very sophisticated tool that is very easy to use." —*Brian Jordan, Manager, Asset Information Management, Sprint*

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—*Alan Espiritu, Civil Engineering Associate, City of Los Angeles, Bureau of Engineering*

"After I downloaded and installed the evaluation copy of Autodesk MapGuide, I developed and deployed my first application very quickly. Since then, we have deployed eight unique applications using our corporate intranet and our existing GIS databases, which include millions of features and records. Now, instead of waiting days for hard-copy maps or reports, as our previous systems required, PG&E employees across the state of California can get immediate answers to their questions involving spatial information."
—*Jody Cummings, Senior GIS Specialist, Pacific Gas & Electric Company, California*

APPENDIX II

PG&E EVALUATING WILDLIFE PROTECTIVE DEVICES 1998-1999

(FIELD FORM)

PG&E - EVALUATING WILDLIFE PROTECTIVE DEVICES 1998-99.

Name:		**Division:**	
Date:		**Circuit Name:**	
City:		**Circuit Number:**	
Crossroads:		**Pole Number:**	

Pole Type (check):	1-0 Xformer	3-0 Xformer	Cutout Riser	Air Sw	Cap Bank	V.Regltor	Recloser	Buck-Arm	Tangent	Sectionlze	Other			
Product (check):	Bush Cover	Jump Insul	Perch guard	BFDiverter	Sqrl guard	Pole Wrap	Alt Perch	T-perch	Av Ball	Insl Wire	Mid SS	Other		
Manufactr (circle): (Include no. of units)	Fargo	Salisbury	Moloney	Cust Plstic	Hendrix	Squirrely	Eritech	Raychem	Petr Sales	Preform	Guthrie	Webb	Lneway	Other
Where Installed:	Xformr bush	Pothead	Cap Bush	V.R.Bush	Recl Bush	Sect Bush	Jumpers	Metl brkt	Wd xarm	Cutouts	Kyle	Other		
Correctly Installed:	Yes	No (Explain)												
Condition of device(s):	Soot	Tracking	Torn	Hanging	Discolor	Holes	Broken	Loose	Deformed	Other	Ok			

Land Uses:	North	South	East	West			
Photo Numbers:							
Contaminants:	Chemical	Dust	Salt	Smoke	None	Exhaust	Other
Solar Exposure:	Full	Partial	None	Other			
Evidence of Wildlife Use: (Give location of evidence)	Guano	Feathers	Pellets	Nut cache	Carcass	Other	None
Pole Safe: (yes or no) If no, why?							
Comments:							

APPENDIX III

RATIO OF 14 DIFFERENT WILDLIFE PROTECTIVE DEVICES TO OVERHEAD LINE MILES FOUND IN EACH DIVISION

Legend

BFD – Bird Flight Diverter, Regular & Large

Cond Spacers - Conductor Spacers (3 sizes)

Electrostatic Guard – Guthrie, Regular & Large

Fargo Cvr - Fargo Cover

Line Cvr – Lineway Cover

Molny Cvr – Moloney Cover

PVC Tube - PVC Jumper Insulation

Sal BWC – Salisbury Bare Wire Cover

Sal LWC – Salisbury Line Wire Cover

Squirrely Cover

Ratio of 14 Different Wildlife Protective Devices to Overhead Line Miles Found by Division (Since 8/96)

Division	BFD	Line Miles	BFD1/linemiles
Fresno	580	10426	0.0556
Sacramento	200	4815	0.0415
North Coast	120	9796	0.0122
North Valley	24	9230	0.0026
Yosemite	0	10423	0
Kern	0	6967	0
Los Padres	0	4324	0
Sierra	0	7540	0
Stockton	0	5941	0
North Bay	0	2668	0
Central Coast	0	5627	0
San Jose	0	2268	0
De Anza	0	1430	0
East Bay	0	1592	0
Diablo	0	2126	0
Mission	0	1780	0
Peninsula	0	2273	0
San Francisco	0	557	0
Totals:	924		

Division	Electrostatic Guard	Line Miles	Electro/linemiles
Diablo	1450	2126	0.6820
De Anza	600	1430	0.4196
Sierra	506	7540	0.0671
Stockton	98	5941	0.0165
East Bay	18	1592	0.0113
Kern	49	6967	0.0070
Mission	12	1780	0.0067
Peninsula	12	2273	0.0053
North Coast	24	9796	0.0024
Fresno	0	10426	0
Yosemite	0	10423	0
North Valley	0	9230	0
Los Padres	0	4324	0
North Bay	0	2668	0
Sacramento	0	4815	0
Central Coast	0	5627	0
San Jose	0	2268	0
San Francisco	0	557	0
Totals:	2769		

Division	Fargo Cvr	Line Miles	FargoCvr/line miles
Sierra	2900	7540	0.3846
Stockton	1000	5941	0.1683
North Valley	600	9230	0.0650
Sacramento	300	4815	0.0623

Division	Line Cvr	Line Miles	LineCvr/linemiles
Sierra	3399	7540	0.4508
Diablo	724	2126	0.3405
San Jose	680	2268	0.2998
Central Coast	1213	5627	0.2156

De Anza	50	1430	0.0350
Mission	50	1780	0.0281
North Bay	50	2668	0.0187
Central Coast	100	5627	0.0178
Fresno	0	10426	0
Yosemite	0	10423	0
Kern	0	6967	0
North Coast	0	9796	0
Los Padres	0	4324	0
San Jose	0	2268	0
East Bay	0	1592	0
Diablo	0	2126	0
Peninsula	0	2273	0
San Francisco	0	557	0
Totals:	5050		

De Anza	240	1430	0.1678
Yosemite	1217	10423	0.1168
East Bay	181	1592	0.1137
Fresno	1148	10426	0.1101
North Coast	790	9796	0.0806
Sacramento	208	4815	0.0432
Los Padres	185	4324	0.0428
North Bay	96	2668	0.0360
North Valley	232	9230	0.0251
Stockton	148	5941	0.0249
Kern	32	6967	0.0046
Peninsula	2	2273	0.0008
Mission	0	1780	0
San Francisco	0	557	0
Totals:	10495		

Ratio of 14 Different Wildlife Protective Devices to Overhead Line Miles Found by Division Cont. (Since 8/96)

Division	Molny Cvr	Line Miles	Molny/linemiles
Fresno	**13556**	**10426**	**1.3002**
Yosemite	11275	10423	1.0817
North Coast	5473	9796	0.5587
North Bay	985	2668	0.3692
Los Padres	1315	4324	0.3041
North Valley	1768	9230	0.1915
Stockton	1009	5941	0.1698
Kern	11110	6967	0.1593
Sierra	1147	7540	0.1521
De Anza	192	1430	0.1343
Sacramento	479	4815	0.0995
San Jose	203	2268	0.0895
East Bay	136	1592	0.0854
Central Coast	365	5627	0.0649
Diablo	82	2126	0.0386
Mission	63	1780	0.0354
Peninsula	50	2273	0.0220
San Francisco	0	557	0
Totals:	49208		

Division	PVC Tube	Line Miles	PVC Tube/linemiles
Fresno	**48204**	**10426**	**4.6234**
Kern	20950	6967	3.0070
Yosemite	29800	10423	2.8590
De Anza	3412	1430	2.3860
San Jose	5200	2268	2.2928
Diablo	4800	2126	2.2578
Los Padres	7900	4324	1.8270
Stockton	3900	5941	0.6565
Mission	1000	1780	0.5618
Sierra	2400	7540	0.3183
North Valley	1400	9230	0.1517
Central Coast	755	5627	0.1342
North Coast	0	9796	0
North Bay	0	2668	0
Sacramento	0	4815	0
East Bay	0	1592	0
Peninsula	0	2273	0
San Francisco	0	557	0
Totals:	129721		

Division	Sal BWC	Line Miles	Sal BWC/linemiles
San Francisco	1982	557	3.5583
Diablo	851	2126	0.4003
Peninsula	726	2273	0.3194
Central Coast	1174	5627	0.2086
De Anza	199	1430	0.1392

Division	Sal LWC	Line Miles	Sal LWC/linemiles
Yosemite	16405	10423	1.5740
Sierra	8590	7540	1.1393
San Jose	2568	2268	1.1323
Fresno	8687	10426	0.8332
Central Coast	3612	5627	0.6420

San Jose	226	2268	0.0996	**Mission**	1110	1780	0.6236
Stockton	310	5941	0.0522	**Diablo**	1075	2126	0.5056
North Bay	126	2668	0.0472	**Stockton**	2790	5941	0.4696
Sacramento	226	4815	0.0470	**North Coast**	4053	9796	0.4137
North Coast	423	9796	0.0432	**Sacramento**	1855	4815	0.3853
Mission	60	1780	0.0341	**North Bay**	729	2668	0.2732
Sierra	192	7540	0.0255	**North Valley**	2049	9230	0.2220
North Valley	222	9230	0.0240	**De Anza**	257	1430	0.1797
Fresno	145	10426	0.0139	**Peninsula**	320	2273	0.1408
Los Padres	59	4324	0.0136	**Los Padres**	454	4324	0.1050
East Bay	20	1592	0.0126	**Kern**	559	6967	0.0802
Yosemite	105	10423	0.0101	**East Bay**	105	1592	0.0660
Kern	9	6967	0.0013	**San Francisco**	0	557	0
Totals:	6829			**Totals:**	55224		

Ratio of 14 Different Wildlife Protective Devices to Overhead Line Miles Found by Division Cont. (Since 8/96)

Division	Cond Spc	Line Miles	Cond Spc/linemiles
Diablo	23	2126	0.0106
Sierra	57	7540	0.0076
Stockton	110	5941	0.0061
North Valley	94	9230	0.0051
North Bay	25	2668	0.0047
Sacramento	34	4815	0.0041
Central Coast	47	5627	0.0041
San Jose	19	2268	0.0029
Fresno	12	10426	0.0012
De Anza	1	1430	0.0007
Yosemite	15	10423	0.0007
Kern	3	6967	0.0004
North Coast	0	9796	0
Los Padres	0	4324	0
East Bay	0	1592	0
Mission	0	1780	0
Peninsula	0	2273	0
San Francisco	0	557	0
Totals:	440		

Division	Squirrely Cover	Line Miles	Squir/linemiles
De Anza	2327	1430	1.6273
San Jose	1633	2268	0.7200
Diablo	1171	2126	0.5508
Sierra	969	7540	0.1850
Central Coast	908	5627	0.1614
Kern	1123	6967	0.1612
North Coast	1264	9796	0.1290
Fresno	843	10426	0.0808
East Bay	124	1592	0.0779
Sacramento	334	4815	0.0694
Mission	89	1780	0.0500
Los Padres	200	4324	0.0462
North Bay	94	2668	0.0352
Stockton	148	5941	0.0249
Yosemite	256	10423	0.0246
Peninsula	31	2273	0.0136
North Valley	38	9230	0.0041
San Francisco	0	557	0.0000
Totals:	11553		

APPENDIX IV

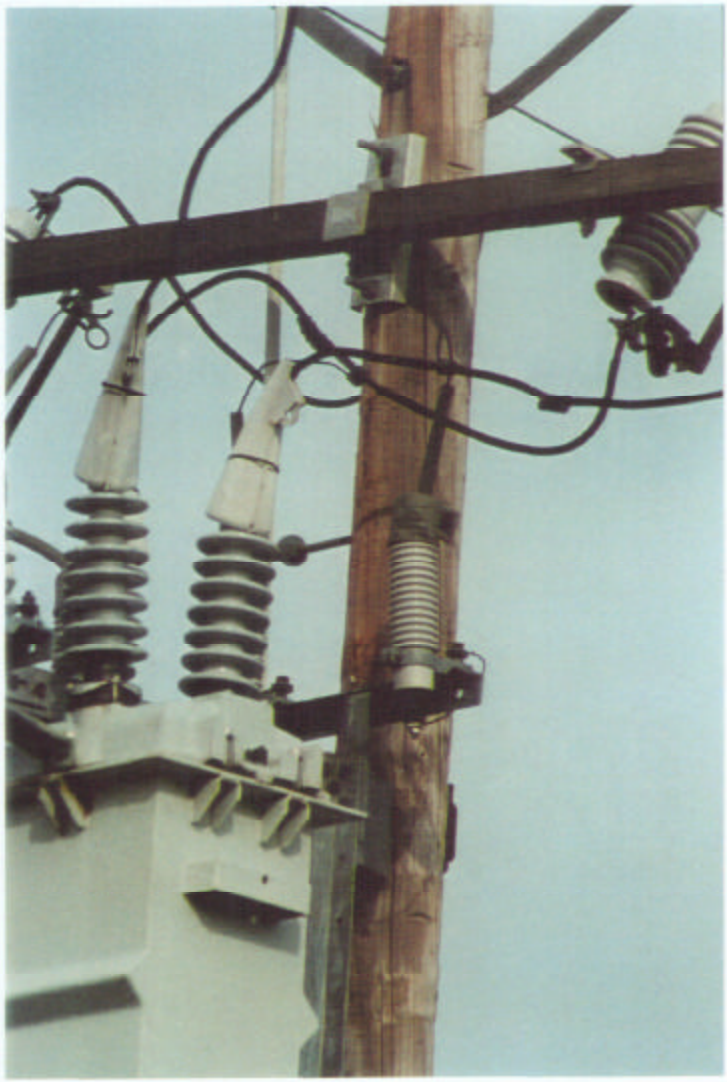
SELECTED PHOTOS OF DEGRATED WILDLIFE PROTECTIVE DEVICES

(Pole #1 SW)
(Pole #9 SW)
(Pole #34 FW)

Pole # 1SW

Bushing Cover on Potential Transformer Shows Evidence of Tracking at Base of Unit

Pole # 9 SW



Bushing Cover Installed on Lightning Arrester Shows Evidence of Tracking

Pole # 34FW

Bushing Cover on CSL Switch is Cut, Exposing Jumper Connection

APPENDIX V

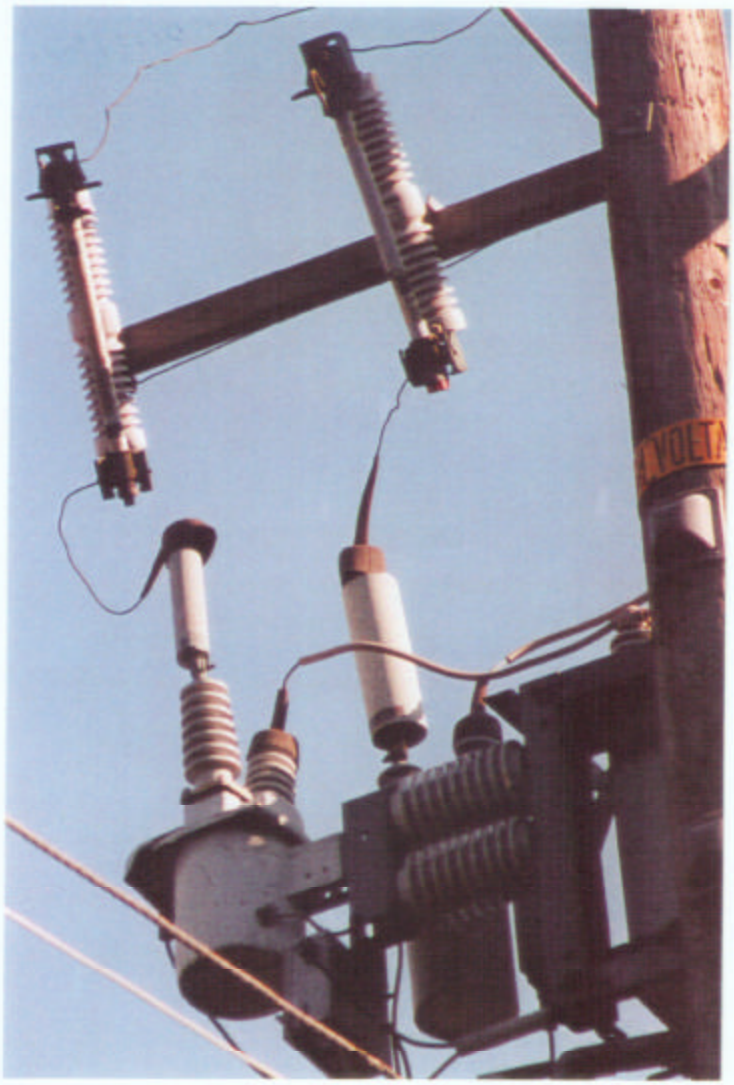
SELEVTED PHOTOS OF IMPROPERLY INSTALED WILDLIFE PROTECTIVE DEVICES

(Pole #7)
(Pole #10)
(Pole #37)

Pole # 7

Homemade Triangular Perch Guard Installed on Wrong Side of Upper Crossarm

Pole # 10



Bushing Cover Installed Above the Bushing-Mounted Cutout

Pole # 37

Bushing Cover & Electrostatic Guard Installed on the Same Pothead

Also, Electrostatic Guard Installed Below the Second Skirt